United States
Department
of Agriculture

Forest Service

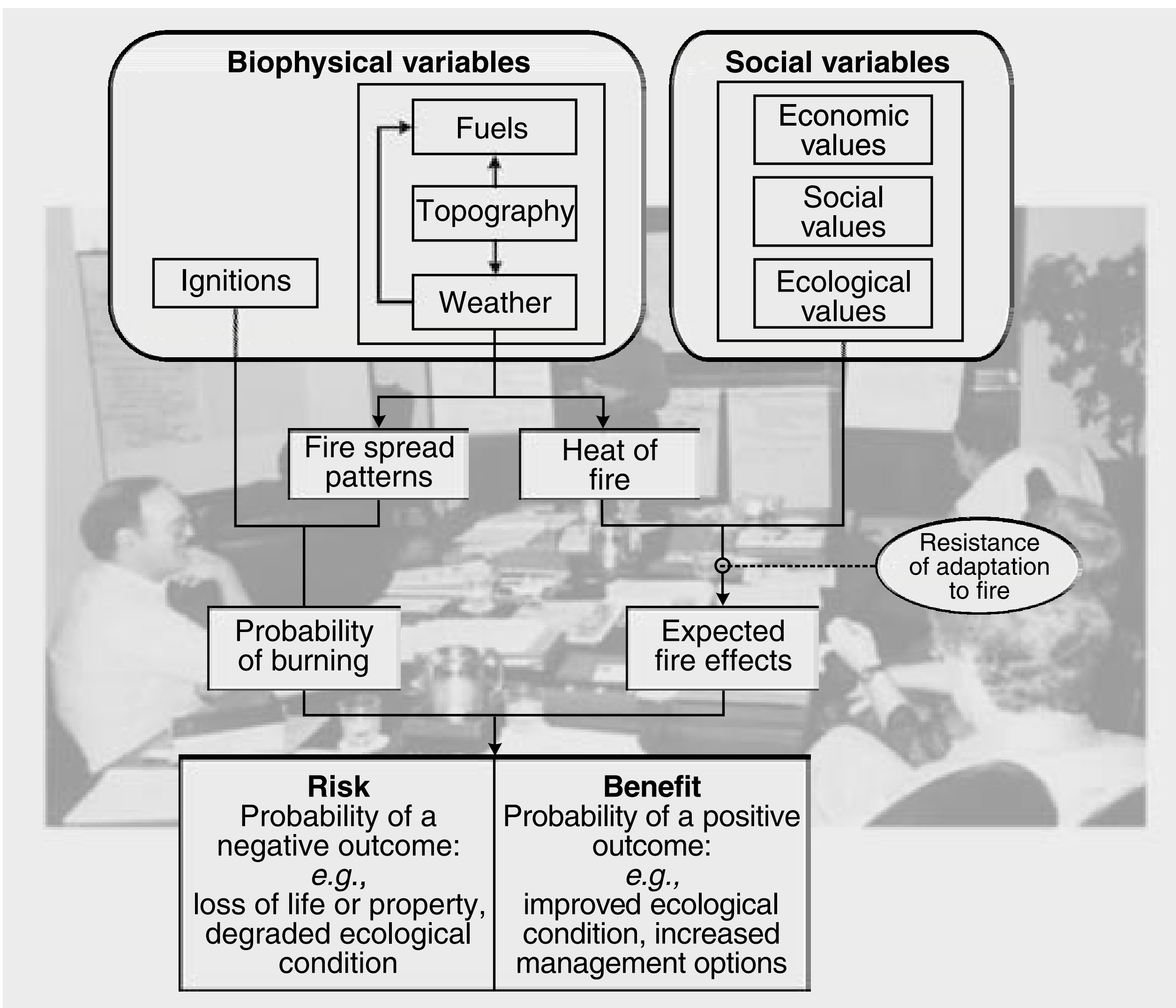
**Rocky Mountain
Research Station**

General Technical
Report RMRS-GTR-127

April 2004

# Exploring Information Needs for Wildland Fire and Fuels Management

Carol Miller
Peter Landres



Miller, Carol and Landres, Peter. 2004. **Exploring information needs for wildland fire and fuels management.** RMRS-GTR-127. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 36 p.

## Abstract

We report the results of a questionnaire and workshop that sought to gain a better and deeper understanding of the contemporary information needs of wildland fire and fuels managers. Results from the questionnaire indicated that the decision to suppress a wildland fire was most often influenced by factors related to safety and that the decision to allow a fire to burn was influenced by a variety of factors that varied according to land management objectives. We also found that managers anticipated an increase in the use of wildland fire, but that these increases will be moderate due to a variety of constraints that will continue to limit the use of wildland fire. From the workshop, we learned that managers will need to become increasingly strategic with their fire and fuels management planning, and that the information used to support tactical fire operations may prove to be insufficient. Furthermore, the managers participating in the workshop indicated the functional linkage between land management and fire management planning is lacking. We suggest that effective fire management planning requires information on the benefits and risks to a wide variety of values at landscape scales, integration with land management objectives, and a long-term perspective.

***Keywords:*** strategic planning, wildland fire use, decision support

## Authors

**Carol Miller** is a Research Ecologist with the Aldo Leopold Wilderness Research Institute of the Rocky Mountain Research Station in Missoula, MT. After a brief career as an electrical engineer, she received a M.S. degree in Forest Sciences and a Ph.D. degree in Ecology at Colorado State University. She has studied various aspects of managing and restoring natural fire regimes.

**Peter Landres** is a Research Ecologist with the Aldo Leopold Wilderness Research Institute of the Rocky Mountain Research Station in Missoula, MT. He received his B.S. degree in Natural Science from Lewis and Clark College and his Ph.D. degree in Biology and Ecology from Utah State University. His research aims to develop the knowledge, strategies, and tools for improving the management of wilderness.

This report is a product of Joint Fire Science Program project #99-1-3-16 "Wildland Fuels Management: Evaluating and Planning Risks and Benefits."

You may order additional copies of this publication by sending your mailing information in label form through one of the following media. Please specify the publication title and series number.

**Fort Collins Service Center**

| | |
|---|---|
| **Telephone** | (970) 498-1392 |
| **FAX** | (970) 498-1396 |
| **E-mail** | rschneider@fs.fed.us |
| **Web site** | http://www.fs.fed.us/rm |
| **Mailing address** | Publications Distribution<br>Rocky Mountain Research Station<br>240 West Prospect Road<br>Fort Collins, CO 80526 |

Rocky Mountain Research Station
Natural Resources Research Center
2150 Centre Avenue, Building A
Fort Collins, CO 80526

# Contents

# Introduction

The challenges for wildland fire and fuels managers have never been greater. Decades of effective fire suppression and land use change have led to fuel accumulations, uncontrollable wildland fires, increased risk to human life and property, and the deterioration of fire dependent ecosystems. The United States Forest Service estimates that 39 million acres of National Forest System land alone are at risk from catastrophic fire (U.S. General Accounting Office 1999). Managers must determine how to satisfy the legal and policy mandates to restore the natural role of fire in the face of extreme risks caused by accumulated fuels. To overcome these challenges, managers will need to base their decisions on solid science, relying on the information and tools provided by fire researchers. It is paramount that fire researchers, in turn, have a solid understanding of the most critical information needs of wildland fire managers. In this publication we report the results of a questionnaire and workshop that sought to gain a better and deeper understanding of the contemporary information needs of wildland fire and fuels managers.

Prior to the 1970s, fire suppression was the dominant fire management policy across all the federal land management agencies. For example, Forest Service fire management policy in 1926 was to contain any fire to 10 acres or less, and in 1935, the 10-acre goal was coupled with the goal of controlling all fires by 10 a.m. of the day following initial detection. Fire managers did not have to decide whether to suppress an ignition – instead, fire management decisions applied to tactical suppression operations and risk assessments focused on short term consequences for socioeconomic values that may be threatened by fire. Any longer term planning that was done focused on preparedness.

Since then, the fire policies of the federal agencies have been revised and reviewed, ultimately evolving into the first comprehensive interagency fire policy: the 1995 Federal Wildland Fire Management Policy. This interagency policy affirmed the essential role of fire for ecosystem sustainability, declaring, "Wildland fire, as a critical natural process, must be reintroduced into the ecosystem." Although some wildland fires had previously been allowed to burn as "prescribed natural fires" in remote wildernesses and parks, the 1995 policy provided direction for extending these activities into areas outside parks or wilderness. A clear message from the policy was that the use of wildland fire on federal lands would increase and become one of the tools in a fire manager's toolbox.

The 1995 policy also acknowledged that the preceding decades of fire suppression contributed to accumulations of hazardous fuels, changes in vegetation structure, uncontrollable wildland fires, and increased risk to human life and property. To reduce these threats, the policy encouraged a more proactive approach to fire management. It recommended that fire management decisions be based on sound assessments of all the risks and that the assessments include the analysis of tradeoffs against the benefits of fire use, including the consideration of long term consequences. In 2001, an update to the policy was released as the 2001 Federal Wildland Fire Management Policy. The update reaffirmed, in particular, the importance of risk assessment and strategic planning.

Such changes in federal fire policy undoubtedly affect the nature of a wildland fire manager's job. The new policy directs managers to perform proactive, strategic planning, include the long-term consequences of their decisions in risk assessments, and consider explicitly the benefits of fire along with its risks. What specific challenges do wildland fire and fuels managers expect to face, and what kinds of information will they require, as they strive to accomplish these additional responsibilities and the increased application of wildland fire use? Have these challenges and information needs changed from those previously identified for traditional fire and fuels management (Barney 1979; Evison 1985; Schuster and others 1997; Cleaves and others 2000)?

To increase our understanding of today's information requirements for wildland fire and fuels management, we (1) developed and administered a questionnaire and (2) actively engaged a small group of fire managers in a workshop. The purpose of the questionnaire was to better understand the types of information currently used for wildland fire and fuels management and to identify the challenges that many managers face. The workshop was designed to identify the most important information needs for strategic fuels management and wildland fire use. In this paper, we present results of this questionnaire and conclusions derived from the workshop.

# Questionnaire: Identifying Information Used and Challenges for Fire and Fuels Management

Our objective with the questionnaire was to gain an understanding of the factors that influence fire and fuels management decisions and to identify the information that is currently used to support those decisions. We also wanted to identify the specific kinds of challenges and constraints facing managers today. We developed the questions after discussions with several individuals with fire and fuels management experience and an extensive literature review of fire management and policy. We solicited feedback from these individuals on early drafts of the questionnaire. The purpose of the questionnaire was exploratory in nature, and for this reason we did not seek statistically significant results and therefore did not develop a formal pre-test survey instrument.

In February 2000, we solicited input from approximately 300 people from the USDA Forest Service and the USDI National Park Service, Bureau of Land Management, Fish and Wildlife Service, and Bureau of Indian Affairs. A convenient sample of people employed in fire and fuels management positions was used. Names and addresses were obtained from various paper and electronic directories. When both electronic and postal addresses were available, we sent both email and hardcopy versions of the survey. We were interested in understanding the decision-making environment from the perspectives of individual managers and made no attempt to apportion the number of questionnaires by administrative unit. As such, multiple individuals within the same unit may have been sent the questionnaire and our results represent fire and fuels managers rather than administrative unit or fire management programs. We allowed approximately five weeks for people to respond to the questionnaire, which contained questions in a variety of formats including numerical ranking and rating, check-off, short answer, and open-ended. We estimated that the questionnaire would require 30-60 minutes to complete, depending on the thoroughness of the response. The questions were divided into four main topic areas: wildland fire management, wildland fuels management, management tools, and management challenges. The complete questionnaire is in Appendix A.

We received 146 responses, of which 140 were complete. The six incomplete questionnaires were at least partially usable and, where possible, we included these incomplete responses when we summarized results for each question. Five agencies and 23 states were represented: 47 responses from USDA Forest Service (USFS) employees, 32 from Bureau of Land Management (BLM), 31 from National Park Service (NPS), 29 from Fish and Wildlife Service (FWS), and two from Bureau of Indian Affairs (BIA). One respondent indicated affiliation with both USFS and BLM and four people failed to provide their agency affiliations; we did not include these responses in analyses of interagency differences. The managers who responded were involved in fire and fuels management at broad (e.g., FWS zones, USFS and NPS regions) and district levels (e.g., NPS park, USFS districts, FWS refuges). The experience level of respondents was high, with an average of 21 years of experience in fire and/or fuels management. The majority of respondents (55%) described themselves as fire management officers and many were fire and/or fuels specialists (18%). Almost half (46%) of the respondents described ecosystem restoration/preservation as the primary land management objective for their area. Fewer respondents indicated commodity (16%), wildlife (16%), recreation (13%) and cultural/historical heritage (3%) as primary land management objectives. A summary of the questionnaire results is provided in Appendix B.

## *Wildland Fire Management*

To explore how the recent emphasis on wildland fire use (WFU) in federal fire policy might affect fire management activity levels, we asked respondents to estimate the percent of fire starts in the past 10 years that were managed under suppression, confinement, and fire use strategies. We also asked respondents to estimate these percentages for the next 1-3 years. Although respondents indicated that suppression has been (77% of fire starts in the past 10 years) and will remain (67% estimated for the next 1-3 years) the dominant fire management strategy, they predicted a moderate increase in WFU over the next 1-3 years (figure 1). In terms of number of fire starts, this is a modest shift from suppression towards WFU, but because a single fire can burn thousands of acres, this modest shift could result in a dramatic increase in number of acres burned by wildland fire.

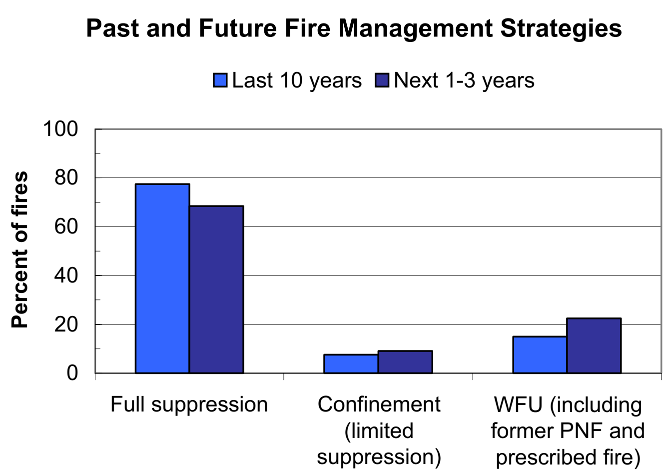



**Figure 1.** Percent of fires managed using full suppression, confinement (limited suppression), and fire use (including WFU and prescribed fire) strategies over the past 10 years compared with expected percentages over the next 1-3 years.

A variety of factors influence the decision whether or not to suppress a wildland fire. We asked managers to numerically rate 29 factors according to how often each factor influenced decisions to suppress wildland fire in the areas for which they are responsible. The rating system used was 0=never, 1=sometimes, 2=often, 3= always, or N/A = not applicable; the mean values for each factor are listed by agency and primary land management objective in tables 1 and 2. In addition to the 29 factors, we allowed "Other" as a valid response and 14 respondents utilized this option; we did not attempt to summarize this category. Overall, the four highest rated factors were: firefighter safety, threats to private property, threats to developments and facilities, threats to human life in the urban interface, and visitor safety (mean values 2.34, 2.21, 2.19, 2.15, respectively). Respondents gave these high ratings to safety factors and potential threats to structures and private property regardless of their agency affiliations, primary land management objectives, or geographic locations. Visitor safety was also highly rated (mean value 1.99), although its rating was somewhat lower for BLM and USFS affiliations (1.87) and where the primary land management objective was commodity production (1.83). Also highly rated were indicators of fire behavior such as: weather forecasts, fire danger rating, and the presence of heavy fuels (1.95, 1.89, 1.81). The four lowest-rated factors were: lack of interagency cooperation, forest health, absence of a fire management plan, and conflicting management objectives (0.73, 0.88, 0.95, 0.99). Mean ratings varied by primary land agency mission (table 1) and by the primary land management objectives (table 2). For example, timber values received a mean rating of 1.83 from respondents who worked for areas with commodity production as a primary land management goal, whereas respondents from areas with ecosystem objectives rated timber values 1.06 (table 2). Similarly, wildlife habitat was rated 2.04 by FWS and only 1.44 by USFS and 1.65 by BLM (table 1), reflecting the greater emphasis placed on wildlife management by the FWS than other agencies.

We asked respondents who work in areas where WFU is permitted to use the same rating system and rate 12 beneficial effects of wildland fire according to how often

**Table 1.** Average ratings for factors influencing decisions to suppress wildfires by agency, ordered by total average ratings.

| Factor | Total average (n) | Agency | | | | |
|---|---|---|---|---|---|---|
| | | BIA (n) | BLM (n) | NPS (n) | USFS (n) | USFWS (n) |
| Firefighter safety | 2.34 (140) | 2.00 (2) | 2.39(31) | 2.13(31) | 2.38(45) | 2.62 (26) |
| Private property | 2.21 (140) | 2.00 (2) | 2.23(31) | 2.13(31) | 2.29(45) | 2.19 (26) |
| Developments/facilities | 2.19 (138) | 2.50 (2) | 2.19(31) | 2.16(31) | 2.13(45) | 2.32 (25) |
| Human life in the WUI | 2.15 (140) | 3.00 (2) | 2.13(31) | 2.06(31) | 2.13(45) | 2.31 (26) |
| Visitor safety | 1.99 (139) | 2.00 (2) | 1.87(31) | 2.13(31) | 1.87(45) | 2.23 (26) |
| Weather forecasts | 1.95 (140) | 2.00 (2) | 2.06(31) | 1.74(31) | 1.87(45) | 2.19 (26) |
| Crown fire potential | 1.89 (136) | 3.00 (2) | 1.55(31) | 1.29(30) | 1.67(45) | 1.71 (26) |
| Heavy fuels | 1.81 (140) | 1.50 (2) | 1.97(31) | 1.48(31) | 1.84(45) | 1.96 (26) |
| Multiple ignitions/nearby fire activity | 1.74 (138) | 2.50(2) | 1.94(31) | 1.55(31) | 1.82(45) | 1.56 (25) |
| Overextended staff/resources | 1.66 (140) | 2.00(2) | 1.97(31) | 1.52(31) | 1.69(45) | 1.27 (26) |
| Endangered/threatened species | 1.63 (136) | 1.00(2) | 1.80(30) | 1.53(30) | 1.36(45) | 2.08 (26) |
| High fire danger | 1.59 (139) | 2.50(2) | 1.84(31) | 1.73(31) | 1.93(43) | 2.00 (24) |
| Insufficient staff--national fire activity | 1.56 (140) | 1.50(2) | 1.81(31) | 1.48(31) | 1.60(45) | 1.15 (26) |
| Cultural sites | 1.55 (139) | 1.50(2) | 1.70(30) | 1.58(31) | 1.44(45) | 1.54 (26) |
| Wildlife habitat | 1.53 (140) | 1.50(2) | 1.65(31) | 1.19(31) | 1.44(45) | 2.04 (26) |
| Smoke and air quality | 1.51 (138) | 1.50(2) | 1.45(31) | 1.43(30) | 1.39(44) | 1.85 (26) |
| Recreational/scenic values | 1.43(139) | 2.00(2) | 1.45(31) | 1.17(30) | 1.60(45) | 1.46(26) |
| Political/public opposition to fire | 1.37(138) | 2.00(2) | 1.16(31) | 1.10(31) | 1.57(44) | 1.56(25) |
| Timber values | 1.35(126) | 2.00(2) | 1.30(30) | 0.64(22) | 1.80(45) | 1.21(24) |
| Soil erosion/stream water quality | 1.35(138) | 2.00(2) | 1.65(31) | 0.97(29) | 1.29(45) | 1.54(26) |
| Other unique natural resources | 1.14(138) | 1.50(2) | 1.26(31) | 1.10(31) | 1.02(44) | 1.27(26) |
| Insufficient time/staff--documentation | 1.14(138) | 0.00(2) | 1.16(31) | 1.13(31) | 1.32(44) | 0.92(26) |
| Controversial fire policy | 1.08(138) | 1.50(2) | 1.10(31) | 1.00(30) | 1.05(43) | 1.26(23) |
| Post-fire exotic weed invasion | 1.07(136) | 0.50(2) | 1.63(30) | 1.00(31) | 0.82(44) | 1.08(25) |
| Conflicting management objectives | 0.99(137) | 1.00(1) | 1.03(30) | 0.80(30) | 1.16(45) | 0.88(26) |
| Lack of fire management plan | 0.95(134) | 2.00(2) | 0.96(28) | 0.72(29) | 1.22(45) | 0.48(25) |
| Forest health | 0.88(136) | 0.50(2) | 0.81(31) | 0.66(29) | 1.04(45) | 0.96(25) |
| Interagency boundaries | 0.73(135) | 0.50(2) | 0.97(29) | 0.83(30) | 0.69(45) | 0.36(25) |

each influenced the decision to use wildland fire. One hundred five individuals responded to this part of the questionnaire, and average ratings are listed by agency and primary land management objective in tables 3 and 4. Overall, "allowing natural processes" most often influenced decisions to use wildland fire with a mean rating of 2.26. Several factors were rated very similarly (mean ratings between 1.77 and 1.83) including: reduced fuel hazards, enhanced wildness, improved wildlife habitat, reduced undesirable fire effects in the future, improved resource conditions, and increased vigor and growth. The reduction of crown fire potential, increased regeneration, and reduced smoke from future large unwanted wildfires influenced decisions to use wildland fire least often (1.08, 1.32, 1.33, respectively). The ratings varied across agencies (table 3) and primary land management

**Table 2.** Average ratings for factors influencing decisions to suppress wildfire by primary land management objective, ordered by total average ratings.

| Factor | Total average (n) | Primary objective | | | | |
|---|---|---|---|---|---|---|
| | | Recreation (n) | Commodity (n) | Cultural (n) | Ecosystem (n) | Wildlife (n) |
| Firefighter safety | 2.34(140) | 2.25(20) | 2.65(23) | 2.25(4) | 2.23(63) | 2.55(24) |
| Private property | 2.21(140) | 2.40(20) | 2.39(23) | 2.75(4) | 2.10(63) | 2.00(24) |
| Developments/facilities | 2.19(138) | 2.25(20) | 2.35(23) | 3.00(4) | 2.08(62) | 2.16(23) |
| Human life in the WUI | 2.15(140) | 2.25(20) | 2.17(23) | 3.00(4) | 2.03(63) | 2.15(24) |
| Visitor safety | 1.99(139) | 2.21(19) | 1.83(23) | 3.00(4) | 1.95(63) | 1.95(24) |
| Weather forecasts | 1.95(140) | 2.15(20) | 2.35(23) | 2.00(4) | 1.77(63) | 2.10(24) |
| Crown fire potential | 1.89(136) | 1.90(20) | 1.87(23) | 1.75(4) | 1.42(62) | 1.61(24) |
| Heavy fuels | 1.81(140) | 2.20(20) | 2.26(23) | 2.00(4) | 1.53(63) | 1.95(24) |
| Multiple ignitions/nearby fire activity | 1.74(138) | 1.60(20) | 2.30(23) | 2.00(4) | 1.59(62) | 1.58(23) |
| Overextended staff/resources | 1.66(140) | 1.95(20) | 2.26(23) | 1.75(4) | 1.47(63) | 1.25(24) |
| Endangered/threatened species | 1.63(136) | 1.39(18) | 2.00(23) | 1.50(4) | 1.48(61) | 2.00(24) |
| High fire danger | 1.59(139) | 2.10(20) | 2.22(23) | 2.50(4) | 1.69(61) | 2.00(22) |
| Insufficient staff--national fire activity | 1.56(140) | 2.05(20) | 2.00(23) | 1.50(4) | 1.39(63) | 1.10(24) |
| Cultural sites | 1.55(139) | 1.65(20) | 1.61(23) | 1.75(4) | 1.56(62) | 1.40(24) |
| Wildlife habitat | 1.53(140) | 1.45(20) | 1.83(23) | 1.25(4) | 1.35(63) | 1.95(24) |
| Smoke and air quality | 1.51(138) | 1.55(20) | 1.52(23) | 1.33(3) | 1.52(62) | 1.60(24) |
| Recreational/scenic values | 1.43(139) | 1.65(20) | 1.61(23) | 2.00(4) | 1.26(62) | 1.40(24) |
| Political/public opposition to fire | 1.37(138) | 1.60(20) | 1.41(22) | 1.50(4) | 1.21(63) | 1.53(23) |
| Timber values | 1.35(126) | 1.56(18) | 1.83(23) | 1.00(3) | 1.06(54) | 1.32(23) |
| Soil erosion/stream water quality | 1.35(138) | 1.60(20) | 1.52(23) | 1.50(4) | 1.12(61) | 1.55(24) |
| Other unique natural resources | 1.14(138) | 1.32(19) | 1.17(23) | 1.25(4) | 1.07(62) | 1.30(24) |
| Insufficient time/staff--documentation | 1.14(138) | 1.60(20) | 1.39(23) | 1.00(4) | 1.01(62) | 0.90(24) |
| Controversial fire policy | 1.08(138) | 1.05(19) | 1.09(22) | 1.33(3) | 0.98(62) | 1.41(21) |
| Post-fire exotic weed invasion | 1.07(136) | 0.95(19) | 1.57(23) | 1.25(4) | 1.05(61) | 0.95(23) |
| Conflicting management objectives | 0.99(137) | 1.35(20) | 1.36(22) | 1.00(3) | 0.77(62) | 0.90(24) |
| Lack of fire management plan | 0.95(134) | 1.37(19) | 1.33(21) | 0.75(4) | 0.71(60) | 0.65(24) |
| Forest health | 0.88(136) | 1.25(20) | 1.09(23) | 0.50(4) | 0.75(60) | 0.74(23) |
| Interagency boundaries | 0.73(135) | 1.05(20) | 1.00(22) | 0.50(4) | 0.62(59) | 0.35(24) |

**Table 3.** Average ratings for factors influencing the decision to use wildland fire by agency, ordered by total average ratings.

| Factor | Total average (n) | Agency | | | | |
|---|---|---|---|---|---|---|
| | | BIA (n) | BLM (n) | NPS (n) | USFS (n) | USFWS (n) |
| Allowing natural processes | 2.26(102) | 1.00(1) | 1.68(22) | 2.79(24) | 2.43(35) | 1.94(18) |
| Improved wildlife habitat | 1.83(103) | 2.00(1) | 1.86(22) | 1.79(24) | 1.63(35) | 2.28(18) |
| Reduced fuel hazards | 1.80(103) | 2.00(1) | 1.95(22) | 1.71(24) | 1.74(35) | 1.78(18) |
| Improved resource conditions | 1.80(103) | 1.00(1) | 1.82(22) | 1.96(24) | 1.54(35) | 2.00(18) |
| Enhanced wildness/naturalness | 1.79(102) | 1.00(1) | 1.36(22) | 2.08(24) | 1.91(35) | 1.61(18) |
| Enhanced vigor and growth | 1.78(103) | 0.00(1) | 2.00(22) | 1.92(24) | 1.46(35) | 2.00(18) |
| Reduced undesirable effects in future | 1.77(103) | 2.00(1) | 1.55(22) | 1.75(24) | 1.89(35) | 1.83(18) |
| Reduced suppression costs | 1.57(103) | 2.00(1) | 1.64(22) | 1.33(24) | 1.49(35) | 1.89(18) |
| Increased future management options | 1.52(103) | 1.00(1) | 1.59(22) | 1.63(24) | 1.37(35) | 1.56(18) |
| Reduced smoke in future | 1.33(101) | 1.00(1) | 1.29(21) | 1.17(24) | 1.20(35) | 1.78(18) |
| Increased regeneration | 1.32(102) | 1.00(1) | 1.41(22) | 1.71(24) | 0.97(34) | 1.33(18) |
| Reduced crown fire potential | 1.08(100) | 1.00(1) | 1.00(22) | 1.00(22) | 1.03(35) | 1.35(17) |

objective (table 4). For example, the mean rating given to "allowing natural processes" by respondents whose primary land management objective was ecosystem-oriented was 2.63, whereas the mean ratings were lower for respondents with management objectives related to commodities and wildlife (1.75 and 1.79, respectively) (table 4). NPS and USFS respondents rated "allowing natural processes" higher than any other factor (2.84 and 2.41, respectively), and FWS respondents rated wildlife habitat as the highest of all factors (2.35) (table 3).

We also asked these same 105 individuals to rate eight consequences of continued fire suppression according to how often each influenced the decision to use wildland fire. Average ratings are listed by agency and primary land management objective in tables 5 and 6. Overall, four factors were rated similarly (mean ratings between 1.70 and 1.77): reduction of fire-dependent habitat, increased fuel hazards, increased future threats, and degradation of ecosystem or forest health. Increased crown fire potential, increased smoke from future large

**Table 4.** Average ratings for factors influencing the decision to use wildland fire by primary land management objective, ordered by total average ratings.

| | | Primary objective | | | | |
|---|---|---|---|---|---|---|
| Factor | Total average (n) | Recreation (n) | Commodity (n) | Cultural (n) | Ecosystem (n) | Wildlife (n) |
| Allowing natural processes | 2.26(102) | 2.08(12) | 1.75(16) | 1.00(2) | 2.61(51) | 1.87(15) |
| Improved wildlife habitat | 1.83(103) | 2.00(13) | 1.75(16) | 1.50(2) | 1.82(51) | 1.93(15) |
| Reduced fuel hazards | 1.80(103) | 2.00(13) | 1.88(16) | 1.50(2) | 1.78(51) | 1.40(15) |
| Improved resource conditions | 1.80(103) | 1.77(13) | 1.56(16) | 1.00(2) | 1.88(51) | 1.53(15) |
| Enhanced wildness/naturalness | 1.79(102) | 1.42(12) | 1.56(16) | 1.00(2) | 2.02(51) | 1.73(15) |
| Enhanced vigor and growth | 1.78(103) | 1.85(13) | 1.81(16) | 0.50(2) | 1.86(51) | 1.73(15) |
| Reduced undesirable effects in future | 1.77(103) | 2.00(13) | 1.44(16) | 1.50(2) | 1.78(51) | 1.47(15) |
| Reduced suppression costs | 1.57(103) | 1.62(13) | 1.75(16) | 1.00(2) | 1.61(51) | 1.47(15) |
| Increased future management options | 1.52(103) | 1.62(13) | 1.44(16) | 0.50(2) | 1.57(51) | 1.33(15) |
| Reduced smoke in future | 1.33(101) | 1.33(12) | 1.00(15) | 1.00(2) | 1.41(51) | 1.47(15) |
| Increased regeneration | 1.32(102) | 1.33(12) | 1.31(16) | 1.00(2) | 1.36(50) | 1.43(14) |
| Reduced crown fire potential | 1.08(100) | 1.23(13) | 0.88(16) | 0.50(2) | 1.12(49) | 1.07(14) |

**Table 5.** Average ratings for consequences of continued fire suppression that influence decisions to use wildland fire by agency, ordered by total average ratings.

| | | Agency | | | | |
|---|---|---|---|---|---|---|
| Factor | Total average (n) | BIA (n) | BLM (n) | NPS (n) | USFS (n) | USFWS (n) |
| Reduced fire-dependent habitat | 1.77(102) | 1.00(1) | 1.52(23) | 1.58(24) | 1.89(35) | 2.19(16) |
| Increased fuel hazards | 1.74(103) | 2.00(1) | 1.96(24) | 1.45(22) | 1.66(35) | 1.83(18) |
| Increased future threats to values | 1.71(105) | 1.00(1) | 2.00(24) | 1.63(24) | 1.57(35) | 1.78(18) |
| Degraded ecosystem health | 1.70(102) | 0.00(1) | 1.52(23) | 1.65(23) | 1.83(35) | 1.76(17) |
| Increased suppression costs | 1.52(106) | 2.00(1) | 1.38(24) | 1.33(24) | 1.67(36) | 1.50(18) |
| Reduced future mgmt options | 1.38(102) | 1.00(1) | 1.17(24) | 1.32(22) | 1.63(35) | 1.29(17) |
| Increased smoke in future | 1.38(106) | 2.00(1) | 1.29(24) | 1.08(24) | 1.39(36) | 1.78(18) |
| Increased crown fire potential | 1.13(102) | 1.00(1) | 1.08(24) | 1.00(21) | 1.17(36) | 1.18(17) |

**Table 6.** Average ratings for consequences of continued fire suppression that influence decisions to use wildland fire by primary land management objective, ordered by total average ratings.

| | | Primary objective | | | | |
|---|---|---|---|---|---|---|
| Factor | Total average (n) | Recreation (n) | Commodity (n) | Cultural (n) | Ecosystem (n) | Wildlife (n) |
| Reduced fire-dependent habitat | 1.77(102) | 1.86(14) | 1.41(17) | 1.50(2) | 1.80(50) | 2.17(12) |
| Increased fuel hazards | 1.74(103) | 2.00(14) | 1.94(18) | 1.50(2) | 1.69(48) | 1.57(14) |
| Increased future threats to values | 1.71(105) | 1.79(14) | 2.00(18) | 2.00(2) | 1.66(50) | 1.57(14) |
| Degraded ecosystem health | 1.70(102) | 1.64(14) | 1.53(17) | 0.50(2) | 1.76(49) | 1.92(13) |
| Increased suppression costs | 1.52(106) | 1.79(14) | 1.44(18) | 1.50(2) | 1.53(51) | 1.47(15) |
| Reduced future mgmt options | 1.38(102) | 1.43(14) | 1.50(18) | 0.50(2) | 1.38(48) | 1.15(13) |
| Increased smoke in future | 1.38(106) | 1.50(14) | 1.22(18) | 1.50(2) | 1.35(51) | 1.67(15) |
| Increased crown fire potential | 1.13(102) | 1.36(14) | 1.11(18) | 0.50(2) | 1.08(48) | 1.29(14) |

fires, reduced management options in the future, and increased fire suppression costs influenced WFU decisions least often (1.13, 1.38, 1.38, 1.52, respectively). These ratings also varied across agencies (table 5) and primary land management objective (table 6). For example, respondents whose primary land management objective was wildlife-oriented gave "reduction of fire-dependent habitat" fairly high ratings (mean value 2.17) whereas respondents with management objectives related to commodities rated this factor much lower (mean value 1.41) (table 6).

## *Wildland Fuels Management*

An increasingly important component of wildland fire management is fuels management and we asked the survey participants about the objectives, methods, and limitations of their fuels management programs. Ninety-four percent (138) of the respondents had active fuels treatment programs to reduce or treat fuel hazards.

We asked these managers to use the 0 to 3 rating system (0 = never, 1=sometimes, 2 = often, 3 = always, or N/A = not applicable) and rate eight different objectives according to how often each was the primary objective for a fuel treatment. Reducing fuel loadings and resource enhancement were rated the highest (mean ratings 2.23 and 2.05, respectively), followed by reducing potential damage from wildfire, reducing future wildfire intensity, simulating the effects of natural disturbance, reducing future wildfire size, reducing potential suppression costs, and restoring historic scenes (1.87, 1.81, 1.72, 1.60, 1.40, 1.05, respectively).

We asked which of six treatment methods (naturally ignited fire, prescribed fire, cuttings and mechanical treatments, herbicide, grazing, and a combination of cuttings, mechanical treatments, and prescribed fire) were included in their fuels management program, and what percentage of the acres treated to date had been treated by each method[1]. Of the six fuels management strategies, prescribed fire was the most widely used with an average of 60% of the treated acres (figure 2). Cuttings and mechanical treatments (13%) or a combination of cuttings, mechanical treatments, and prescribed fire (16%) were also responsible for a substantial portion of treated acres (figure 2). Respondents indicated that naturally ignited fire was used as a fuel treatment on an average of

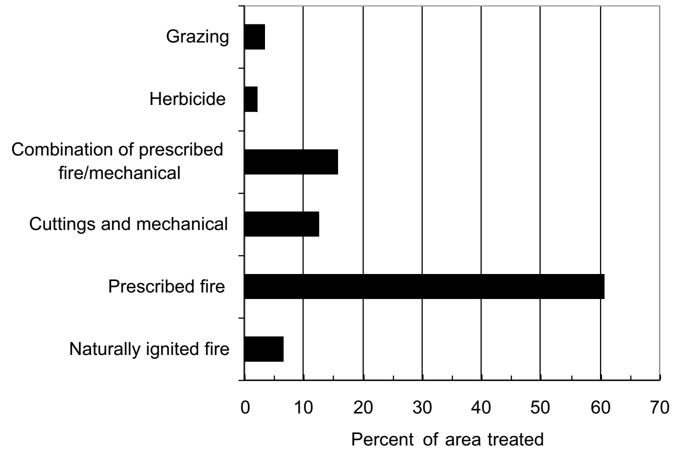



**Figure 2.** Percent of area treated for fuels reduction using six different strategies.

6% of treated acres and herbicide and grazing were used on 2% and 3% of the acres, respectively (figure 2). Use of different fuels treatment strategies also varied across agencies and primary land management objective. NPS and USFS respondents reported a much higher percentage of acres being treated with naturally ignited fire (average of 12% and 9%, respectively) when compared to either BLM or FWS respondents (about 1% reported by each group) (figure 3). Respondents whose primary land management objective was ecosystem-oriented treated more acres with naturally ignited fire (average 10%) than the other respondents (figure 4).

To determine how managers prioritize fuels treatment efforts on the landscape, we asked respondents to use the 0 to 3 rating system on each of 11 factors according to how often it is considered when prioritizing fuels treatments. To prioritize treatments, the respondents most often used: vegetation type, fuel hazards, economic feasibility, type of values present, and proximity to boundaries (mean ratings were 2.29, 2.21, 2.09, 1.99, 1.93, respectively). Considered less often were: likelihood of severe large fires, recovery potential of vegetation, topographic position, probability of ignition, pre-settlement fire frequency, and administrative designation of the area as wilderness (1.74, 1.71, 1.54, 1.46, 1.39, 1.00, respectively).

To determine how well fuel treatment program goals are achieved, we asked for an estimate of how many acres per year are planned for fuel treatment and how many acres have actually been accomplished. Although we asked for annual averages and ranges for program goals and accomplishments, many respondents provided only a range or only a single value. We summarized the mean values and if only a range was provided, we took the midpoint to serve as a mean. Several

[1] We removed six responses from our analysis of this question because of an error contained in some of the electronically formatted questionnaires that did not allow respondents to distinguish between naturally ignited wildland fire and management ignited prescribed fire.

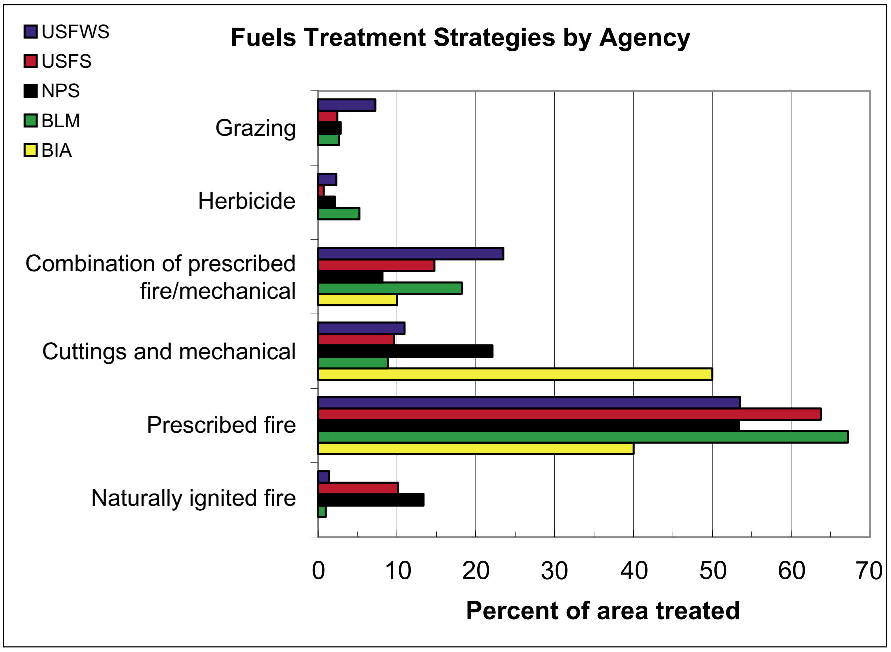



**Figure 3.** Differences among agencies in the percent of area treated for fuels reduction using six different strategies.

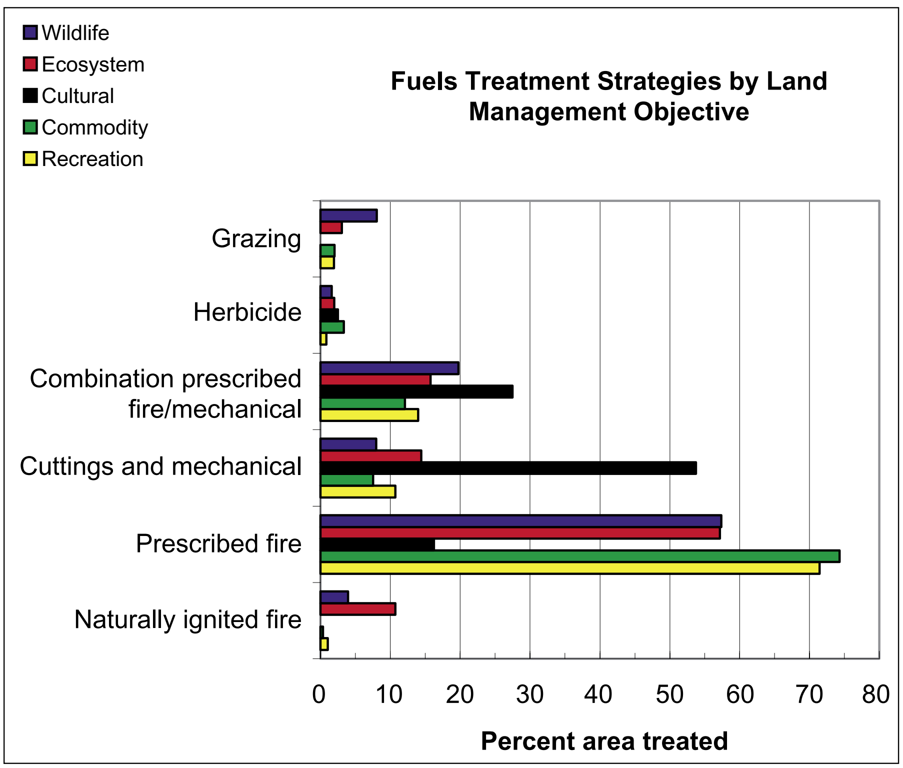



**Figure 4.** Differences among primary land management objective in the percent of area treated for fuels reductions using six different strategies.

respondents provided information on accomplishments for two or more separate time periods in the past. In such cases, we used the most recent time span because we felt that would be most representative of the current fuel treatment program. Fuel treatment programs ranged in magnitude from just a few acres treated per year to hundreds of thousands of acres. Approximately one-fourth of the managers (35) reported that they achieved or exceeded the acres planned for treatment. For those who did not achieve goals for fuels treatment acres, they fell short on average by about 40% of planned acres.

In those cases where the acreage treated each year falls short of the planned acreage, we asked managers to rate seven factors according to how often each factor was responsible for treated acres lagging behind planned acres. Unsuitable weather conditions were most often the reason for non-attainment of fuel treatment goals (mean rating 1.86), followed by inadequate resources (i.e., money, personnel) to conduct the treatments (1.44), and air quality regulations (1.19). NEPA (National Environmental Policy Act) regulations, political issues, lack of internal support, and public opposition to treatments were less often responsible for non-attainment of fuel treatment goals (1.02, 0.95, 0.81, 0.73, respectively). There was little difference in ratings among agencies or among different primary land management goals.

### *Management Tools*

Dozens of tools and various types of information can support wildland fire and fuels managers' decisions. We listed 50 types of information and tools in nine different categories and asked respondents to indicate which ones were used to support fire and fuels management decisions in their management area. The seven categories were: fire history data, mapped data in GIS (Geographic Information System) format, mapped data not in GIS format (i.e., paper maps), computerized databases, computerized modeling tools, other computer tools, and other general tools. For the discussion of results below, we have grouped these categories into three general classes: data, computerized tools, and other non-computerized tools. Results are summarized in table 7.

Respondents indicated a high use of data in a variety of forms. Data on post-settlement fire history (e.g., fire atlas data) are used to support decisions in the management areas of 83% of the respondents. Pre-settlement fire history data (e.g., from fire-scarred trees) are less widely used (65% of the respondents' areas). Spatial data on fire perimeters, ignitions, vegetation, fuels, topography, roads and trails, and residences and other structures are being widely utilized in many areas (as many as 80% of respondents), and an impressive percentage of respondents indicated the use of these spatial data in digital GIS format (55-81%). Information contained in the computer database FEIS (Fire Effects Information System) is used to support decisions in 80% of the respondents' management areas while NIFMID (National Integrated Fire Management Interagency Database) is used only in 30% of the areas.

Computerized tools available to fire and fuels managers are quite numerous, and we listed a total of 27 computerized tools and databases. Of the five fire behavior computerized modeling tools listed, the fire behavior model BEHAVE is by far the most widely used (95%), followed by FARSITE (39%) and RERAP (Rare Event Risk Assessment Process, 36%). The most widely used fire weather analysis tool is Firefamily+, with 62% of respondents indicating the use of this or one of its modules FIRDAT (or PCFIRDAT) and CLIMATOLOGY. AFFIRMS (Administrative and Forest Fire Information Retrieval and Management System) is also widely used (47%) and several respondents volunteered WIMS (Weather Information Management System), as it was not provided on the survey form. Of the fire effects modeling tools, FOFEM (First Order Fire Effects Model) and SASEM (Simple Approach Smoke Estimation Model) were selected by the most respondents (55% and 52%, respectively), followed by other models that estimate smoke emissions and/or dispersion: CONSUME (43%), NFSPUFF (17%), EPM (11%), VALBOX (5%), and PLUMP (3%). SIAM (Structure Ignition Assessment Model) was selected by only 2% of the respondents. Other computerized tools that are widely used are WFSA (Wildland Fire Situation Analysis, 67%) and two programs needed for the NFMAS (National Fire Management Analysis System) process: PCHA (Personal Computer Historical Analysis, 42%) and IIAA (Interagency Initial Attack Assessment, 40%).

Although the use of computer technology is high, "low tech," non-computerized sources of information are still widely used. For example, 70% of respondents indicated that fuel model photo series are used, 67% indicated that research publications are used to support decisions in their area, 55% report the use of fire behavior nomograms, 38% report the use of fire danger rating pocket cards, and 20% reported using the Hewlett-Packard (HP) hand-held calculator.

### *Management Challenges*

We asked three open-ended questions to gain insight into the challenges facing fire and fuels managers: (1) What is most likely to prevent attainment of your management objectives? (2) Which of your management objectives most severely conflict with each other? and (3) Is there a unique feature of your physical or social environment that makes decision-making especially difficult? Factors preventing attainment of management objectives that were often mentioned were: funding or budget issues (mentioned 45 times), staffing (41 times), smoke or air quality (42), weather or burn windows (30), public support or opinion (18), NEPA (10), and TES (Threatened and Endangered Species; mentioned 15 times). Management objectives that severely conflict with fire or fuels management objectives that were most often mentioned were: TES protection (mentioned 18 times), smoke or air quality (15), commodities including timber and grazing (11), wildlife (9), and cultural or historical site protection (9). Unique features of the

**Table 7.** Information and tools used to support fire and fuels management decisions.

| Category/subcategory | Information or tool | Number of responses |
|---|---|---|
| FIRE HISTORY DATA | | |
| | Post-settlement fire records | 121 |
| | Pre-settlement data | 95 |
| MAPPED DATA IN GIS FORMAT | | |
| | Fire occurrence records | 104 |
| | Ignitions | 94 |
| | Vegetation | 117 |
| | Fuels | 92 |
| | Topography | 104 |
| | Roads and trails | 111 |
| | Residences | 83 |
| | Other | 23 |
| MAPPED DATA NOT IN GIS FORMAT | | |
| | Fire occurrence records | 70 |
| | Ignitions | 54 |
| | Vegetation | 53 |
| | Fuels | 64 |
| | Topography | 52 |
| | Roads and trails | 56 |
| | Residences | 80 |
| | Other | 12 |
| COMPUTERIZED DATABASES | | |
| | FEIS | 111 |
| | NIFMID | 42 |
| | Other computerized databases | 19 |
| COMPUTERIZED MODELING TOOLS | | |
| Fire behavior/spread | | |
| | BEHAVE | 136 |
| | FARSITE | 58 |
| | NExUS | 16 |
| | RERAP | 51 |
| | FBP | 12 |
| | Other fire spread/behavior models | 5 |
| Fire danger/weather | | |
| | AFFIRMS | 67 |
| | CLIMATOLOGY | 34 |
| | FIRDAT | 40 |
| | Firefamily+ | 90 |
| | MfFSF | 5 |
| | CFFDRS | 11 |
| | FWI | 9 |
| | Other fire danger/fire weather models | 26 |
| Fire effects | | |
| | CONSUME | 62 |
| | EPM | 14 |
| | FOFEM | 80 |
| | NFSPUFF | 25 |
| | PLUMP | 6 |
| | SASEM | 75 |
| | SIAM | 2 |
| | VALBOx | 8 |
| | Other fire effects models | 5 |
| OTHER COMPUTER TOOLS | | |
| | FIRES | 35 |
| | FORBS | 43 |
| | FVS-FFE | 10 |
| | IIAA | 56 |
| | PCHA | 59 |
| | WFAS | 53 |
| | WFSA_Plus98 | 97 |
| | Other computer tools | 11 |
| OTHER TOOLS | | |
| | HP | 27 |
| | Fire danger rating cards | 56 |
| | Fire behavior nomograms | 81 |
| | Fuel model photo series | 102 |
| | Research publications | 98 |

physical or social environment that make decision-making especially difficult and that were mentioned most often were: smoke or air quality issues (mentioned 15 times), fuels or fire behavior (13), public opinion (12), and private property or urban interface (10).

### *Summary*

The factors most often influencing the decision to suppress a wildland fire were related to safety and fire behavior. This was true when results were summarized by agency, geographic region, or primary land management objective (e.g., tables 1 and 2). Given the emphasis on safety in agency policies and management plans, this was not surprising.

The questionnaire examined the influence of a variety of factors that may be considered in the decision to allow a wildland fire to burn, including a range of potential benefits from the fire and several consequences of continued fire suppression. The factors that most often influence decisions to allow a wildland fire to burn varied with the primary land management objectives. For example, in areas focused on ecosystem restoration or preservation, the decision to use wildland fire was most often influenced by fire's ability to allow natural processes, whereas in areas with wildlife objectives, fire's ability to improve wildlife habitat was rated as the most influential factor.

The most widely used fuels treatment strategy by the managers responding to this questionnaire was prescribed fire (figure 2). The use of naturally ignited fire for fuels management has not become very widespread, as indicated by the relatively low percentage of acres treated in this fashion. For managers responding to this questionnaire, WFU was implemented most often for the purposes of restoring natural processes, and it tended to be implemented on lands with ecosystem-oriented land management goals.

We found heavy reliance on computer technology by the managers responding to this questionnaire. Virtually all of the managers responding to the questionnaire reported the use of computerized tools and/or models. Approximately three-fourths of the respondents indicated the use of spatial data in GIS format for decision support. The fire behavior prediction model BEHAVE is used almost universally by the managers responding to our questionnaire. The computer models FARSITE (which predicts rate and direction of fire spread across a landscape) and RERAP (predicts the probability that a fire will travel a specified distance) are used more often where WFU is allowed. Similarly, managers from areas with WFU programs reported higher use of computer models that predict fire effects.

Respondents consistently expected a shift in fire management from suppression to WFU. Compared to the last 10 years, managers responding to this questionnaire expected to implement more WFU in the next 1-3 years while relying less on full suppression (figure 1). The degree of this shift is expected to be relatively modest, however (<10 %), suggesting that many constraints to WFU remain. The types of constraints most often mentioned tended to be outside the manager's control; these included weather,airquality concerns, funding, and staffing.

Many results from this questionnaire were similar to those from two recent surveys of USDA Forest Service fire staff, both of which focused primarily on the planning and use of management-ignited prescribed fire (Cleaves and others 2000, Barrett and others 2000). Although the questionnaire we used was broader than these previous studies and was not limited to the planning and use of prescribed fire, many of our findings were consistent. Both Barrett and others (2000) and Cleaves and others (2000) reported that the main objective for prescribed fire was hazard reduction, a finding consistent with the high rating given to "reducing fuel loadings" in our questionnaire. Reintroduction of fire and game habitat were rated as important objectives for prescribed fire in the two previous surveys and were also highly rated by the respondents to our questionnaire. Major barriers to prescribed burning reported by Cleaves and others (2000) and Barrett and others (2000) included air quality and smoke management, inadequate funding, inadequate staffing, and available time windows for burning. Respondents to our questionnaire also mentioned these same factors as being most likely to prevent attainment of management objectives. Barrett and others (2000) found that the level of use and training in GIS technologies was high despite its relatively recent development. We also found a strong dependence on GIS technology and information.

## Workshop: Identifying Information Needs

To build on the insights gained from the questionnaire and improve our understanding of the information needed for strategic fuels and fire management, we convened a small workshop in April 2000 entitled *Managing the risks and benefits of wildland fire: a workshop to identify common information needs for fuels management and wildland fire use*. Our primary goal for the workshop was to solicit input from fire and fuels managers to help us identify critical information needs for implementing wildland fire use (WFU). Although this was the explicitly stated goal around which we organized the workshop, a broader purpose of the workshop was to give us an opportunity to learn from the collective knowledge and experience of wildland fire and fuels managers. We sought to generate thoughtful and creative discussion about complex and difficult management challenges.

We selected 14 members of the fire and fuels management community to participate in the two-day workshop held in Missoula, Montana. We did not try to assemble a representative cross-section of the fire management community but instead emphasized depth of experience and knowledge. The group included fire management officers, wildland fire specialists, fuels specialists, fire planners, and agency fire ecologists (Appendix C). Employees of USFS, BLM, USFWS, and CDF (California Department of Forestry and Fire Protection) were represented[2], most of whom work in the northern Rockies. We encouraged the workshop attendees to approach discussions from a broad perspective and to be as inclusive as possible when discussing issues.

Prior to the workshop, we mailed out information packets that included background material on the workshop topics. The workshop relied heavily on group discussion, and it was from these discussions that we increased our understanding of the challenges surrounding WFU today. The discussions had four themes: (1) challenges and planning solutions, (2) evaluating risks and benefits, (3) WFU objectives, and (4) information needs. In the following sections, we summarize the most important points made in each of these discussions.

## *Challenges and Planning Solutions*

As an introduction to the workshop, we asked two of our participants to present an overview of the challenges of using wildland fire and to discuss potential planning solutions. These presentations served to launch the topics for group discussion.

Wildland fire use hinges on the "go/no-go" decision: whether or not to suppress a wildland ignition once it is discovered. Myriad factors must be considered, resulting in an extremely complex decision-making process. The decision to use wildland fire needs to be made shortly after the detection of a fire (Zimmerman and Bunnell 1998), and yet the decision calls for a thorough assessment of the risks. This risk assessment must also consider that risks will change during the many weeks an individual fire may burn. The managers attending the workshop pointed out that multiple ignitions make this analysis even more difficult. Administrative boundaries present some of the most difficult challenges from both planning and operational standpoints. For example, fires often do not obey a wilderness or National Forest boundary, and decision-makers often do not have the information available for a multi-unit cross-boundary risk assessment. The group agreed that an added challenge to fire and fuels management is the increasing number of homes and developments being built in and adjacent to wildlands.

An assessment of risk is central to the go/no-go decision, and there was considerable discussion about the risk aversion of decision-makers and how the risk posture of an individual can constrain the use of wildland fire. The risk-averse nature of many decision-makers may limit the amount of WFU and one member of the group stressed the importance of successfully implementing small, fail-safe fires for gradually building both experience and confidence in WFU. It was noted that, in time, an individual's risk aversion could be reduced.

According to the managers attending this workshop, the challenges for WFU are compounded by potential conflicts with other resource management objectives. One of the most difficult conflicts is between WFU and air quality. The group predicted that this conflict would become an increasingly intractable problem in the future as the use of fire increases on public lands.

Several participants felt that, even if the major challenges for WFU could be surmounted, the long-term success of WFU is extremely tenuous. For WFU to be successful in the long-term, reliable monitoring of the fire program and the cumulative effects of WFU will be necessary. One major concern is that many wildland fire managers are working under the assumption that they are doing the right thing by implementing WFU, yet they currently lack information on the cumulative effects of WFU and do not have the ability to measure their success with restoring the natural process of fire. This concern is especially important in areas where fire exclusion has significantly altered the ecosystem state and where restoration of the natural role fire may be difficult, if not impossible, under such conditions.

The group also discussed challenges for wildland fuels management. Management staff may be uncertain about where to treat fuels and how to prioritize fuel treatments across a landscape with a variety of vegetation types, fire regimes, effects from fire exclusion, and fuel conditions. The group pointed out that as management goals diversify and strive to consider the values of a diverse public, treatments should no longer be prioritized according to a single dominant interest such as timber values. Areas need to be targeted with a variety of land management objectives in mind and must

[2] Several representatives from the National Park Service were invited but unable to attend due to conflicting NPS fire meetings.

consider recreation, wildlife, ecosystem preservation, and commodity interests. These diverse objectives can be difficult to accomplish given the constraints of limited time and resource availability.

Given the complexities of the environment under which WFU decisions are made, the importance of having a pre-loaded plan in place was emphasized. The group agreed that a key component to this pre-planning is an assessment of the risks and benefits of WFU. GIS was suggested as a powerful technological tool for developing fire management plans. A variety of cultural, wildlife, and other information can be available in advance so when an ignition does occur, it is known what values could be at risk from that fire. Workshop members agreed that a landscape scale perspective is essential, but that it is difficult to maintain a landscape perspective in the heat of the moment. As a result, it was suggested that fire management plans be integrated with land management plans. Many participants voiced their frustration with land management planning processes that lag the development of fire management plans.

The fire management plan on the Bitterroot National Forest (BNF) was presented as an example of a program that has attempted to grapple with many of these challenges. The BNF implements fire management strategies according to type of fire regime, location, and values at risks. Areas closest to the wildland urban interface are also at the lowest elevation and are characterized by a high frequency natural fire regime. Here is where the BNF has been most active with prescribed fire fuels treatments but departure from the natural fire regime was still estimated to be 7-10 fire cycles. Current fire-free intervals also exceed historical intervals in the roaded, highly valued recreation areas that occur at slightly higher elevations. The high-elevation subalpine fir forests have not been affected by fire exclusion and are considered to be within their range of natural variation, but fires that do occur here can become quite large and difficult to control. In the wilderness portion of the management area, about 25% of the fire starts are managed as WFU. The other fire starts were suppressed for a variety of reasons, including the lack of available resources to manage the fire as WFU. This is especially the case during periods of high fire activity when resources are allocated to fire suppression activities in the other fire management zones that have more socioeconomic values-at-risk.

### *Evaluating Risks and Benefits*

The 2001 Federal Wildland Fire Policy considered a sound risk assessment the foundation to fire management and clearly stated that wildland fire management decisions must rely heavily on an assessment of tradeoffs between fire risks and the net gains to public benefit. The managers attending this workshop concurred and pointed out that this occurs every time a go/no-go decision is made. For example, when deciding whether or not to suppress a wildland fire, a manager is aware that each decision carries with it probabilities of negative and positive outcomes. The decision to suppress a wildland fire is made when the social, economic, and ecological risks outweigh the potential benefits from the fire. Alternatively, wildland fires in remote wilderness areas may pose little risk when compared to the potential benefits and the decision may be instead to allow the fire to burn. Managers striving to restore the natural role of fire to fire-dependent ecosystems while protecting life and property weigh the short-term risks of fire against its long-term benefits.

We presented a conceptual framework for evaluating fire risks and benefits that integrates the biophysical environment and the social environment (figure 5). Fire risk was defined as the probability of loss or injury due to fire and can be quantified in terms of the probability of fire-damaged property, loss of life, or diminished air quality from smoke. We defined fire benefits as the probability of gain resulting from fire. These benefits could include removal of accumulated fuels, creation of plant establishment sites, enhancement of habitat diversity, creation of critical habitat for certain wildlife species such as black-backed woodpeckers, increased water yield, and other benefits. In this conceptual framework, risk and benefit are functions of three variables: (1) the probability of a fire occurring within a specific area, (2) the expected fire effects if a fire did occur, and (3) value of the area (Miller and others 2000). The workshop group liked this conceptual model because it helped clarify the issues involved in making the go/no-go decision and provided a logical and defensible set of guidelines for decision-making.

### *Wildland Fire Use Objectives*

There was extensive discussion about the use of wildland fire for fundamentally different objectives. We encountered some confusion because several of the workshop participants felt that WFU was synonymous with natural process objectives. For example, one participant commented, "With fuels management, the end result is the objective of reduced fuels, and with WFU, the end result is allowing natural processes. Strategic fuels treatment is very different by nature than letting fire romp around." Other group members disagreed with

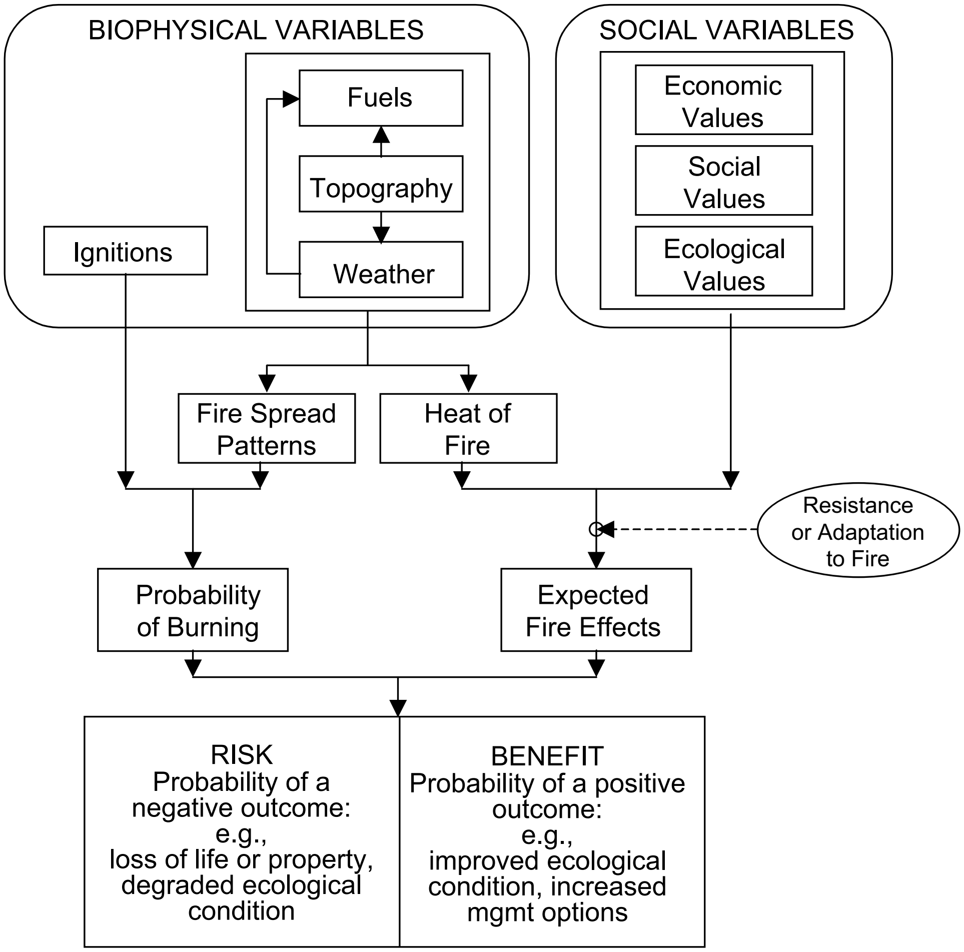



**Figure 5.** Conceptual framework for evaluating the risks and benefits of wildland fire.

this statement because of the expanding role of WFU that is currently endorsed by federal policy. The group agreed that to date, most natural ignitions have been restricted to use within designated wilderness areas and national parks for the objective of allowing natural processes, but the Federal Wildland Fire Policy expands the role of WFU to explicitly include fuels management: "Wildland fire may be used to accomplish a number of resource management purposes, from the reduction of fuel hazards to achieving specific responses from fire-dependent plant species." WFU has most often been applied in places where the primary land management goal is ecosystem preservation. As WFU is applied to other areas, the objectives for its implementation need to be consistent with the resource management objectives of those areas. For example, these objectives may include wildlife habitat, water yield, forage production, or fuel reduction. Several members of the group pointed out that in the past, fuels management may have been regarded as fundamentally different from WFU, but that the real difference was simply the land management goals. The objective for WFU will ultimately derive from land management goals.

Through the discussion, the group concluded that although land management goals and objectives drive the actions taken, it didn't matter whether WFU was used for the objective of managing fuels or allowing natural processes. In either case, an evaluation of risks and benefits was necessary. As one attendee commented, "Management objectives will drive management actions. I want to understand the risks and benefit of either prescribed fire or wildland fire use actions. It doesn't matter which." Another participant made the point that the three legs of fire management (suppression, prescribed fire, and WFU) all required an evaluation of the risks and benefits, and an assessment of the consequences of action vs. no-action. The group agreed that the conceptual framework we presented applied equally well to suppression, prescribed fire, and WFU. We adopted it to help structure and focus many of the ideas that were raised in later discussions.

## *Information Needs*

After the discussions on evaluating risks and benefits and WFU objectives, the group created a list of

**Table 8.** Availability of critical information items that affect the evaluation of risks and benefits for strategic planning at the Forest or project level. Availability was assigned to one of five levels ranging from low (L) to moderate (M) to high (H).

| Information item | Availability | | | | | Comments |
|---|---|---|---|---|---|---|
| | L | ↔ | M | ↔ | H | |
| **Fire Items** | | | | | | |
| Historical weather | | | | | X | |
| Location of fire | | | | | X | |
| Land and fire management objectives | | | X | | | |
| Fire danger rating (seasonality + departure) | | | | | X | |
| Fire behavior | | | | | | System dependent |
| Expected fire effects (weeds, soil, wildlife, etc.) | X | | | | | |
| **Items of Comparison Between Historic and Current Fire Regimes** | | | | | | |
| Intensity /severity | | X | | | | |
| Fire return interval | | | X | | | System dependent |
| Size | X | | | | | |
| Size over time | X | | | | | |
| Occurrence pattern (periodicity) | | | X | | | |
| Time of season (fuels moisture, ecological effects) | X | | | | | |
| Fuels complex (horizontal/vertical) | X | | | | | |
| Species composition | X | | | | | |
| Land use practices (historic) | | | X | | | |
| Condition class | X | | | | | |
| **Social Items** | | | | | | |
| Air quality (nuisance, visibility) | X | | | | | |
| Aesthetics | | | X | | | |
| Commodity/non-commodity limitations (private property, cultural sites, recreation, wildlife values) | X | | | | | |
| Political pressure | | | X | | | Depends |
| Changes in public expectations for the land (agency understanding of public values) | X | | | | | |
| Public safety | | | | | X | |
| Differences in current land use (different uses + public perceptions) | | | | X | | |
| Consequences of failure (effects, management, social) | X | | | | | |
| **Managerial Items[1,2]** | | | | | | |
| Public/ agency/ employee understanding of policy and effects | | X | | | | |
| Management capacity (appropriate staffing, supervisory capability, resources) | X | | | | | |
| Administrative boundaries (proximity to boundary) | | | | | X | |
| Employee safety | | | | | X | |
| **Desired Information Items** | | | | | | |
| Fuels map (detailed, accurate, dynamic) with attribute data | X | | | | | |
| Vegetation map (detailed, accurate, dynamic) with attribute data that derives fuels and wildlife habitat requirements | X | | | | | |
| Probabilistic pixel-specific daily weather streams | X | | | | | |
| Multi-year drought index (10 yrs) | X | | | | | |
| Detailed map of cultural sites with zoom in ability and susceptibility to fire | | | | X | | |
| Detailed map of improvements (i.e., structures) with zoom in feature and susceptibility to fire | | | | X | | |
| Detailed map of T&E with attribute data | X | | | | | |
| Detailed map of weeds | X | | | | | |
| Model of noxious weed / invasive exotic/ type conversion potential | X | | | | | |
| Disturbance history | | X | | | | |
| Fire regimes | | | | | | Depends |
| Knowledge and predictive model of fire effects | X | | | | | |
| Historical vegetation and animal dynamics | X | | | | | |
| How to achieve natural fire effects in current unnatural fuels | X | | | | | |
| Probability of co-occurring fire weather, ignition, fuel conditions (probability of management opportunities) | X | | | | | |
| Value of non commodity resources | X | | | | | |
| Long term consequences of management decisions and actions | X | | | | | |
| Good fire behavior prediction in rangeland/woodland (non forest, non grass) fuels | X | | | | | |

[1]Risk aversion/posture/tolerance was discussed as being highly important, but not suitable for this list.
[2]Need for monitoring was discussed, but not added to the list.

information needed to evaluate the risks and benefits for strategic fire and fuels planning. It was agreed that a single list of information needs would suffice for multiple WFU objectives. The group initially brainstormed a list of items that affect strategic fuels management and WFU decisions. These fell into five general categories which we used to facilitate and organize discussion: (1) fire items, (2) items of comparison between historic and current fire regimes, (3) social items, (4) managerial items, and (5) desired or "wishful" information items. This last category included information that might not be very realistic or feasible to currently obtain, but that would be useful for fire planning. In all, participants identified 83 items that affect strategic fuels management and WFU decisions (Appendix D).

The group then narrowed this expansive list to include only those information items that affect the *evaluation of risks and benefits* for strategic planning at the *project level*. Each item was scrutinized and discussed by the group and a decision was made to include or omit the item. In almost all cases this was a consensus decision, and in cases where there was disagreement, we included the item rather than deleting it. As a result of this refinement process, the group reduced the list of 83 to 46 items (table 8). Items were dropped from the list for three major reasons. First, many items were determined to be solely tactical in nature rather than strategic. For example, weather forecasts are needed for tactical decisions but not for strategic planning. Second, several items affected fire and fuels management decisions but did not affect the evaluation of risks and benefits, so they were dropped. For example, the "Not In My Back Yard (NIMBY)" attitude and a manager's risk posture may each ultimately influence fire management decisions, but neither directly affects the strategic evaluation of risks and benefits. Finally, several items were determined to be redundant and were subsumed by others. For example, "climate" was dropped from the list because it was seen as redundant with "historical weather." The separate items of private property, commodity values, cultural resources, and recreation were aggregated into a single entry under Social Items (table 8): "Commodity/non-commodity limitations (private property, cultural sites, recreation, wildlife values)."

Critical information needs that are currently not being met are of special concern and may represent new priorities for fire research. As a final task, the group collectively rated the availability of each of the information items as low, moderate, or high (table 8). A few items could not be rated because the group felt that the availability of these information items varied too much by ecosystem or by the specific management situation. These items were annotated as "system dependent." In general, items in the fire category were considered by the group to be more available than other information categories. Items of comparison between historic and current fire regimes were considered by the group to be relatively unavailable. The items in the "Desired information" category were considered to be the least available on average.

## Summary

Through a combination of presentations and group discussions we explored the challenges of fire and fuels management and began to outline the most critical information needs for meeting those challenges. Our focus was on the information needed to strategically evaluate the risks and benefits of wildland fire to support the go/no-go decision.

The group of managers attending this workshop agreed that there are not enough acres being burned (either with prescribed fire or WFU) to accomplish objectives of fuel reduction or restoration of natural processes. The use of fire is limited and constrained by a variety of factors including: a rapidly changing WUI, administrative boundaries, conflicting resource objectives, risk-averse managers, and lack of available resources. Given the complexity of the management environment and the time constraints on many management decisions, the group felt that pre-planning would be essential for substantially increasing the number of acres burned. These managers agreed that this planning needs to become increasingly strategic and should involve a thorough assessment of both the risks and benefits of wildland fire.

The implementation of WFU for objectives other than allowing natural processes was a source of confusion because the notion of using natural ignitions for fuel reduction is still a new one. In discussing the use of wildland fire for fuel reduction or other resource objectives, we found that it was essential to distinguish the WFU strategy or tool from the management objective.

The list of information items that were compiled at the workshop represents critical information needs for strategic fire and fuels planning. The information items rated as having high availability indicate information needs that are currently being met. These include information related to safety and fire behavior or fire danger. The information items that were rated as having low availability deserve particular attention because they indicate management needs that are currently unmet. These include information about how current fire regimes differ from historic regimes.

Many important issues were discussed in a short period of time during the workshop and the resulting list of information needs should be considered preliminary. Although a different collection of people would have compiled a different list of information needs, we suspect that the major points raised in discussions would have been raised in most other groups. This list can serve as a launching point for more refined investigations, as well as for prioritizing research efforts.

## Management Implications

### *Fire Management Challenges*

The managers we contacted through the questionnaire and the two-day workshop expected to see an increase in the amount of WFU in their management areas. Whereas most of the WFU in the past had the objective of allowing natural processes (Parsons and others 1986; Agee 1995), the current federal fire policy supports WFU as a tool for a variety of resource management objectives, including fuels management (USDA and USDI 1995). If this policy is successfully implemented and WFU is applied as a fuels treatment strategy, we expect to see the addition of WFU programs to areas outside the designated wilderness and national parks where they have been traditionally confined. The extension of WFU to include objectives other than allowing natural processes may initially cause some confusion among fire and resource managers. The specific management objectives for WFU will tier from the land management goals for the area--clearly defining these will be essential for avoiding confusion and ambiguities in planning.

The results from the questionnaire and the workshop indicate that smoke management poses a significant challenge to managers with WFU programs. The smoke produced by both prescribed fire and wildland fire can compromise air quality (Sandberg and others 2002) and can deteriorate the public support for fire and fuels management programs (Weldon 1996). Although the adverse impacts from smoke can be mitigated if the burning takes place under particular weather conditions (Sandberg 1988), these narrow windows of opportunity constrain the acreage that can be treated for fuels reduction and often occur during the height of the firefighting season when staffing is not available. Barrett and others (2000) and Cleaves and others (2000) reported that factors such as weather and air quality currently limit prescribed fire programs the most. Barrett and others (2000) suggested that the manager's concern is not so much *whether* to use prescribed fire or how much, but rather *how* to prioritize and strategically plan the fires to achieve desired results. We expect WFU programs to face similar constraints.

Results also indicated that funding was a major constraint to achieving management objectives. Many of the questionnaire respondents specifically mentioned the difficulty of planning and administering fire management programs in the midst of annual budget fluctuations and uncertain future funding. We found that managers were concerned about adequate funding as well as having sufficient flexibility to use those funds. This finding is consistent with the results of two surveys on prescribed fire programs (Barrett and others 2000, Cleaves and others 2000), both of which found that funding was the third most important constraint (following weather and air quality concerns) to prescribed fire programs. The policy review in 2001 found that while budget structures had improved somewhat since the 1995 policy was adopted, overall funding was still inadequate to implement the policy (USDA and USDI 2001).

Staffing was also cited as a serious constraint to the accomplishment of fire and fuels management objectives. In addition to a general lack of personnel, inadequate training and expertise of employees was often described as an important barrier. The existing workforce is currently perceived to be insufficient to address the complexities of today's fire management environment. The 2001 policy review also recognized that the need for qualified personnel to implement fire and fuels management programs has largely been unmet (USDA and USDI 2001).

As use of wildland fire increases, so will the number of challenges that fire and fuels managers face. Conflicts with management objectives such as smoke management and protection of threatened or endangered species are bound to intensify with increased WFU. Issues of inadequate funding and staffing are not likely to be resolved quickly. Furthermore, as the WUI expands, so may the diversity of social values that can be impacted by increased WFU (Burns and others 2003).

### *Strategic Planning Solutions*

To meet the challenges of restoring the natural role of fire and reducing existing fuel hazards, managers must become increasingly strategic with their fuels management programs and their decisions to allow wildland fire. Fire management has its roots in tactical operations, and information developed for tactical purposes may prove to be insufficient for strategic planning. For example, while information related to firefighter safety is paramount to supporting incident management decisions

(Butler and Cohen 1998), it is not sufficient information for strategic decision-making. Strategic decision-making needs to consider the short- and long-term consequences of management actions on a wide variety of values and resources. Such an assessment may need to be done across large landscapes and across agency boundaries. Given the complexities involved, this strategic planning and assessment must be done well in advance of the start of a wildland fire (Poncin 1995).

The fire management plan can serve as the strategic planning document for this pre-planning and assessment process (Miller 2003). We suggest that effective strategic fire management planning requires: (1) information on benefits and risks to a wide variety of values, (2) information at landscape scales, and (3) a long-term perspective.

Traditional risk assessment approaches that focus solely on the negative impacts of fire (i.e., risks) will be inadequate for supporting the use of wildland fire. The risks and benefits to a wide spectrum of social and ecological values must be considered. Responses to the questionnaire indicated that the type of values present in an area do indeed influence the decision whether or not to suppress a wildland fire (e.g., table 1). The spectrum of values that need to be considered will widen as WFU is applied to areas other than designated wilderness that have diverse resource management objectives. The managers who participated in the workshop wanted to understand the advantages and disadvantages (i.e., the risks and benefits) of “action” and “no-action” management alternatives.

Management activities traditionally have focused on the scale of a single forest stand and the majority of tools that are currently used in fire and fuels management were developed at this scale (e.g., BEHAVE). Fires can spread across great distances, however, and across political and jurisdictional boundaries. Managers are now being asked to manage for multiple objectives (Cleaves and others 2000, Hann and Bunnell 2001) across large landscapes of interconnecting stands and habitats (Barrett and others 2000). Clearly, strategic planning will need to examine larger landscapes. Our findings suggest that the availability of needed information at these landscape scales has lagged behind management needs. The relatively recent emergence of GIS technology has the potential to rapidly close this gap. Although most of the managers we questioned used spatial data in a GIS, they may not be using these data to their fullest potential. For example, the landscape fire spread model FARSITE was not used nearly as often as the non-spatial fire behavior model BEHAVE.

GIS technology can provide managers with spatially explicit information on the risks and benefits of fire for entire landscapes. Managers participating in the workshop expressed a need for highly detailed, spatially explicit information on a variety of values and features that could be accessed via a simple mouse-click on a map. The need for detailed information on fuels, vegetation, cultural sites, structural improvements, threatened and endangered species, and weeds was specifically expressed. Although this sophistication is not currently available, continued advancements in GIS and computer technologies could allow this need to be satisfied in the not-too-distant future.

A long-term perspective of the future is also a key component to effective strategic planning and the managers participating in the workshop indicated a need for understanding the long-range impacts of their decisions. The most ecologically important and beneficial effects of wildland fire often occur over a much longer time frame than the more easily assessed immediate first-order fire effects (e.g., Bisson and others 2003). The lack of a long-term perspective will almost certainly result in short-term risks and benefits overpowering the long-term consequences in the evaluation of risks and benefits. Tools that can project consequences of management plans and decisions into the future will be required so that long-term consequences can be considered and can enter into the decision-making process.

Strategic planning efforts can also benefit from a long-term perspective of the past. One of the best ways of understanding the current state and dynamics of an ecosystem is through a comparison with historic conditions (Swetnam and others 1999). Information allowing the comparison between historic and current fire regimes was identified as a critical need at the workshop and this type of information was also recognized as being unavailable. Obviously, if information is unavailable or inaccessible to a manager, it cannot be used to support decisions. Indeed, according to managers responding to the questionnaire, information on pre-settlement fire regimes is less often used to support planning and management than more recent fire history information.

## *Linking Land Management and Fire Management*

The foundation for fire management is risk management (USDA and USDI 1995), and the key to sound risk management is strategic fire management planning that is integrated with the land management planning process (Hann and Bunnell 2001). Many of the results from the questionnaire varied according to the primary land management objective, which suggests that fire and fuels management currently do support land management goals to some degree. However, the managers participating in the workshop indicated that there is only a weak functional linkage between land management and fire management planning. They expressed the need for tools and information that would allow them to understand how fire and fuels management would affect other land and resource management goals.

We suggest that decision support tools for fire and fuels management should be developed that project consequences of decisions into the future in the context of land management goals. For example, one of the consequences of suppressing an ignition may be to increase the land area in an older forest age class. Computer models that simulate vegetation dynamics (Chew 1995; Keane and others 1997; Beukema and others 2003) could be used to map the cumulative consequences of suppression decisions in terms of forest age classes across the landscape. Consequences of WFU or fuel management programs could similarly be projected into the future and mapped. These maps could then be compared to the ecological targets or "desired future conditions" described in the land management plan, allowing managers to assess how different fire management strategies will make progress towards or away from long-range land management goals.

## Conclusion

The direction of the most recent federal fire policy, in combination with current fuel hazards, condition of fire-dependent ecosystems, and growing wildland urban interface, has presented a complex set of challenges to wildland fire and fuels managers. We sought to better understand these challenges and to identify the types of information that managers require to address these challenges. We used a questionnaire and convened a workshop to determine the types of information that fire and fuels managers currently use, identify the challenges that many managers face, and understand the most important information needs for strategic fuels management and wildland fire use (WFU).

Based on the results from the questionnaire and workshop, we expect an increase in the use of wildland fire and application of WFU to some areas outside designated wilderness and national parks. However, we expect that these increases will be moderate due to a variety of constraints that are likely to continue to limit the use of wildland fire. These constraints include smoke impacts on air quality, inadequate and uncertain funding, and inadequate staffing. Conflicts with other resource management objectives, administrative boundaries and considerations of the wildland urban interface present additional constraints on the use of wildland fire.

The magnitude and scale of today's fire management challenges will require strategic fire and fuels management planning. Effective strategic planning will require different information than fire and fuels managers have relied upon in the past for tactical operations. Strategic approaches need to be based upon a thorough evaluation of the risks and benefits of fire. This evaluation will need to consider large landscapes and long-term consequences of management actions. We also suggest that new decision support tools and modeling approaches will be needed to address long-term consequences of management actions to different resource values and to functionally tie fire and fuels management to the land management goals for the area.

## Acknowledgments

We greatly appreciate the thoughtful comments and instructive feedback from fire and fuels management staff who responded to the questionnaire and participated in the workshop. Paul Gleason, MaryBeth Keifer, Tobin Kelley and Erin Law provided valuable feedback on early versions of the questionnaire. Anne Black and Greg Aplet provided helpful comments on the manuscript.

## References

Agee, J.K. 1995. Alternatives for implementing fire policy. Pages 107-116 in J.K. Brown, R.W. Mutch, C.W. Spoon, R.H. Wakimoto, tech. coords., Proceedings: symposium on fire in wilderness and park management; March 30-April 1, 1993; Gen. Tech. Rep. INT-GTR-320. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Barney, Richard J. 1979. Wildland fire research needs in the West: Forest Service managers' views. Gen. Tech. Rep. INT-GTR-63. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station.

Barrett, T. M., Jones, J. G., and Wakimoto, R. H. 2000. USDA Forest Service use of spatial information in planning prescribed fires. Western Journal of Applied Forestry. 15: 200-207.

Beukema, S.J., Kurz, W.A., Klenner, W., Merzenich, J., and M. Arbaugh. 2003. Applying TELSA to assess alternative management scenarios. In: Arthaud, G.J., Barrett, T.M., tech. comp. Systems analysis in forest resources, eighth symposium: proceedings; 2000 September 27-30; Snowmass Village, CO. Dordrecht: Kluwer Academic Publishers: 145-154.

Bisson, P.A., Rieman, B.E., Luce, C., Hessburg, P.F., Lee, D.C., Kershner, J.L., Reeves, G.H., Gresswell, R.E. 2003. Fire and aquatic ecosystems of the western USA: current knowledge and key questions. Forest Ecology and Management 178: 213-229.

Burns, S., Porter-Norton, M., Mosher, M., and Richard, T. 2003. People and fire in western Colorado, a working report. Durango, CO: Office of Community Services, Fort Lewis College. 74 p.

Butler, B.W., and Cohen, J.D. 1998. Firefighter safety zones: how big is big enough? Fire Management Notes 58:13-16.

Chew, J. D. 1995. Development of a system for simulating vegetative patterns and processes at landscape scales. Missoula, MT: University of Montana. 182 p. Dissertation.

Cleaves, D. A., Haines, T. K., and Martinez, J. 2000. Influences on prescribed burning activity in the National Forest System. In: Fire and forest ecology: innovative silviculture and vegetation management, 21st Tall Timbers fire ecology conference: proceedings; Tallahassee, FL. Tall Timbers Research Station: 170-177.

Evison, B. 1985. What information is needed for wilderness fire management? Pages 299-301 in Proceedings: Symposium and Workshop on Wilderness Fire. General Technical Report INT-182. Ogden, UT: Intermountain Forest and Range Experiment Station.

Hann, W. J. and Bunnell, D. L. 2001. Fire and land management planning and implementation across multiple scales. International Journal of Wildland Fire. 10: 389-403.

Keane, Robert .E., Long, D.G., Basford, D., and Levesque, B.A. 1997. Simulating vegetation. In: GIS 97, 11th annual symposium on geographic information systems - integrating spatial information technologies for tomorrow: proceedings; 1997 February 17-20; Vancouver, British Columbia, Canada. GIS World, Inc.: 310-315

Miller, C. 2003. Wildland fire use: a wilderness perspective on fuel management. Pages 379-386 in Omi, P.N., and Joyce, L.A., tech. eds. Fire, fuel treatments, and ecological restoration: Conference proceedings; 2002 16-18 April; Fort Collins, CO. Proceedings RMRS-P-29. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Miller, C., Landres, P. B., and Alaback, P. B. 2000. Evaluating the risks and benefits of wildland fire at landscape scales. In: Neuenschwander, L. F., Ryan, K. C., tech. eds. Joint Fire Science Conference and Workshop: proceedings; 1999 June 15-17; Boise, ID. Moscow, ID: University of Idaho: 78-87.

Parsons, D.J., Graber, D.M., Agee, J.K., van Wagtendonk, J.W. 1986. Natural fire management in national parks. Environmental Management 10: 21-24.

Poncin, D.E. 1995. Prescribed natural fire strategies and tactics. Pages 133-135 in J.K. Brown, R.W. Mutch, C.W. Spoon, R.H. Wakimoto, tech. coords., Proceedings: symposium on fire in wilderness and park management; March 30-April 1, 1993; Gen. Tech. Rep. INT-GTR-320. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Sandberg, D.V. 1988. Emission reduction for prescribed forest burning. Pages 372-386 in Mathai, V.C., Stonefield, D.H., eds. Transactions—PM-10: implementation of standards, an APCA/EPA International Specialty Conference. 1988 February 23-24; San Francisco, CA. Pittsburgh, PA: Air Pollution Control Association.

Sandberg, D.V., Ottmar, R.D., Peterson, J.L., and Core, J. 2002. Wildland fire on ecosystems: effects of fire on air. Gen. Tech. Rep. RMRS-GTR-42-vol. 5. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Schuster, E. G., Cleaves, D. A., and Bell, E. F. 1997. Analysis of USDA Forest Service fire-related expenditures 1970-1995. Res. Pap. PSW-RP-230. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station.

Swetnam, T. W., Allen, C. D., and Betancourt, J. L. 1999. Applied historical ecology: using the past to manage for the future. Ecological Applications. 9: 1189-1206.

USDA and USDI. 1995. Federal wildland fire policy. [Online] Available: http://www.fs.fed.us/land/wdfire.htm [August 16, 2002].

USDA and USDI. 2001. Review and update of the 1995 federal wildland fire policy. [Online] Available: http://www.nifc.gov/fire_policy/ [December 15, 2003].

U.S. General Accounting Office. 1999. Western National Forests: A cohesive strategy is needed to address catastrophic wildfire threats. U.S. General Accounting Office GAO/RCED-99-65. 60 pp., P.O. Box 37050; Washington, DC 20013; http://www.gao.gov.

Weldon, L.A. 1996. Dealing with public concerns in restoring fire to the forest. Pages 56-58 in Hardy, C.C., Arno, S.F., eds. The use of fire in forest restoration. Gen. Tech. Rep. INT-GTR-341. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Zimmerman, T. and Bunnell, D.L. 1998. Wildland and prescribed fire management policy, implementation procedures reference guide. National Interagency Fire Center, Boise, ID.

# Appendix A. Questionnaire

## SURVEY OF INFORMATION NEEDS FOR MANAGING THE RISKS AND BENEFITS OF WILDLAND FIRE

The purpose of this survey is to identify the critical information you use and need to manage wildland fuels and fire. Your response will help us build an effective and useful wildland fire decision support tool as part of a project funded by the USDA/USDI Joint Fire Science Program. Although you may have completed other fire management surveys in recent years, this survey is substantially different in focus and scope and is a valuable complement to previous survey efforts.

Where survey questions ask for quantitative numbers, please give your best estimate; precise values are not necessary. We designed this survey to minimize writing, but if you would like to elaborate on any of your answers, please use the space provided or another sheet of paper. All your responses will be held in strict confidence. If you would like a copy of the survey results, please print your name and address on the back of the return envelope. Please do not put this information on the survey itself.

If any of the questions are confusing or if you would like more information about this project, please contact Carol Miller at **cmiller/rmrs@fs.fed.us** or **(970) 498-1387**. There is additional information on our project to develop a wildland fire decision support tool at the end of this survey.

You may already have received an identical survey in electronic form, and if you prefer to respond electronically, please disregard this paper version. If you have not received an electronic version, but would like one, please send your request to the email address above.

*Thank you* in advance for your help and for returning the completed survey by **March 10, 2000**.

Respectfully,

Carol Miller
School of Forestry, The University of Montana
and USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO

Peter Landres
Aldo Leopold Wilderness Research Institute
USDA Forest Service, Rocky Mountain Research Station, Missoula, MT

Paul Alaback
School of Forestry, The University of Montana

**1. Limitations to wildland fire use.**

Please rate each of the following factors according to *how often* it influences decisions to suppress wildland fire in your management area. By "management area" we are referring to the area for which you are primarily responsible, such as a Ranger District, National Forest, National Park, or Region. Rate as: 0 = never, 1 = sometimes, 2 = often, and 3 = always. Use N/A if the factor is not applicable to your situation.

*Resources Threatened*

_____Threats to developments and facilities
_____Threats to property in the urban interface or private inholdings
_____Threats to timber values
_____Threats to recreational or scenic values
_____Threats to cultural sites
_____Threat of soil erosion or degraded stream water quality
_____Threats to wildlife habitat
_____Threats to endangered/threatened species
_____Threats to forest health (for example, potential for insect outbreaks may increase in fire-damaged trees)
_____Threat of post-fire exotic weed invasion
_____Threats to other unique natural resources

*Safety*

_____Threats to human life in the urban interface or private inholdings
_____Threats to visitor safety
_____Threats to firefighter safety

*External Influences*

_____Controversial wildland fire management policy
_____Political pressures and/or public opposition to fire
_____Smoke emissions and air quality issues
_____Other (please describe:)

*Fire Behavior*

_____Existence of heavy fuels, which may increase threats to resources and safety
_____Weather forecasts indicate worsening conditions
_____Fire danger is too high
_____Extreme crown fire potential
_____Multiple ignitions and/or nearby fire activity

*Overhead and Administration*

_____Insufficient staffing and resources due to fire activity and preparedness at the national level
_____Multiple ignitions and/or nearby fire activity have overextended available staff and resources
_____Insufficient time or staff to prepare required documentation
_____Absence of fire management plan (FMP)
_____Lack of interagency cooperation across boundaries
_____Conflicting management objectives

Is there an attempt to assess these factors? If so, which ones, and how is it done?

Additional comments:

**IF ANY PART OF YOUR MANAGEMENT AREA IS MANAGED FOR WILDLAND FIRE USE, PLEASE ANSWER QUESTIONS 2 AND 3; OTHERWISE, GO TO QUESTION 4.**

**2. Benefits of wildland fire use.**

Please rate each of the following benefits of wildland fire according to *how often* it influences decisions to use wildland fire in your management area. Rate as: 0 = never, 1 = sometimes, 2 = often, and 3 = always. Use N/A if the benefit is not applicable to your situation.

_____Reduced fuel hazards
_____Reduced undesirable fire effects in the future
_____Reduced crown fire potential
_____ Increased number and variety of future management options due to fuel hazard reduction and creation of fuelbreaks
_____ Improved resource conditions (for example, stand thinning, reset succession)
_____ Improved wildlife habitat (for example, increased herbaceous forage, snag creation)
_____Enhanced naturalness or wildness qualities
_____Allowing natural processes
_____Enhanced plant vigor and growth
_____Increased regeneration
_____Reduced fire suppression costs
_____Reduced smoke emissions from future large unwanted wildland fires

_____Other (describe:) ________________________________________

Is there an attempt to assess these potential benefits? If so, which ones, and how is it done?

**3. Consequences of continued fire suppression.**

Please rate each of the following consequences of continued fire suppression according to *how often* it influences decisions to use or suppress wildland fire in your management area. Rate as: 0 = never, 1 = sometimes, 2 = often, and 3 = always. Use N/A if the consequence is not applicable to your situation.

_____Increased fuel hazards
_____ Increased future threats to life, property, and other resource values
_____Increased crown fire potential
_____ Reduced management options in the future (for example, narrower windows for prescribed burning)
_____ Reduction of fire-dependent habitat (for example, loss of ponderosa pine or aspen due to succession)
_____Degradation of ecosystem or forest health (for example, potential for insect outbreaks may increase with increasing stand densities)
_____Increased fire suppression costs
_____Increased smoke emissions from future large unwanted wildland fires

_____Other (describe:) ________________________________________

Is there an attempt to assess these consequences? If so, which ones, and how is it done?

**4. Management objectives.**

What is the *major* focus of your management area's land management goals (select all that apply)? By "management area" we are referring to the area for which you are primarily responsible, such as a District, Forest, Park, or Region.

_____Recreation
_____Commodity
_____Cultural/historical heritage
_____Ecosystem restoration/preservation
_____Wildlife
_____Other (describe:)

If you chose more than one, please indicate their priority by ranking them numerically, starting with 1 = most important:

_____Recreation
_____Commodity
_____Cultural/historical heritage
_____Ecosystem restoration/preservation
_____Wildlife
_____Other (describe:) ____________________________________________

Additional comments:

| |
|---|
| |

**5. Management strategies.**

Which of the following fire management strategies are used in your management area (the area for which you are responsible, such as a District, Forest, Park, or Region)?

_____Full suppression
_____Confinement
_____Wildland fire use (including former PNF and prescribed fire)
_____Other: ____________________________________________

Estimate the percentage of fires (or fire starts) that have been managed by each of these strategies *during the past 10 years*.

_____% : Full suppression
_____% : Confinement
_____% : Wildland fire use (including former PNF and prescribed fire)
_____% : Other:

Try to guess the percentage of fires (or fire starts) that will be managed by each of these strategies *in the next 1-3 years*.

_____% : Full suppression
_____% : Confinement
_____% : Wildland fire use (including former PNF and prescribed fire)
_____% : Other: ____________________________________________

Additional comments:

| |
|---|
| |

**6. Fuels treatment program.**

Does your management area currently have an active fuels treatment program to reduce or treat fuel hazards? By "management area" we are referring to the area for which you are primarily responsible, such as a District, Forest, Park, or Region.

_____Yes _____No (SKIP TO QUESTION 7)

A. Please rate each of the following fuels treatment objectives according to *how often* it is the *primary* objective for a fuel treatment in your management area. Rate as 0= never, 1= sometimes, 2=often, and 3=always.

_____Reduce fuel loadings
_____Reduce potential suppression costs
_____Reduce potential damage from wildfire
_____Reduce future wildfire size
_____Reduce future wildfire intensity
_____Simulate the effects of natural disturbance
_____Restore or maintain historic scenes
_____Resource enhancement
_____Other:_______________________________________

B. Which treatment methods or strategies are currently included in the fuels treatment program in your management area (select all that apply)?

_____Naturally ignited fire
_____Prescribed fire
_____Cuttings and mechanical treatments
_____Combination of prescribed fire/cutting/mechanical treatments
_____Herbicide
_____Grazing
_____Other:_______________________________________

Of the acres that have been treated to date, estimate the percentage that have been treated by each method:

_____% Naturally ignited fire
_____% Prescribed fire
_____% Cuttings and mechanical treatments
_____% Combination of prescribed fire/cutting/mechanical treatments
_____% Herbicide
_____% Grazing
_____% Other:_______________________________________

C. Please rate each of the following factors according to *how often* it is considered when prioritizing fuels treatments across the landscape in your management area. Rate as: 0 = never, 1 = sometimes, 2 = often, and 3 = always.

_____Economic feasibility of treating the area
_____Administrative designation of the area as wilderness
_____Proximity of area to wilderness boundary, urban interface, or private inholdings
_____Presettlement fire frequency and number of fire cycles missed
_____Current fuel hazards
_____Likelihood of severe, large wildfires
_____Probability of ignition
_____Type of values present that may be threatened by wildfire
_____Vegetation type
_____Topographic position
_____Post-treatment recovery potential of vegetation
_____Other:_______________________________________

D. General background

How many years has your area had an active fuels treatment management program?_____years

Approximately how many acres are *planned* for
treatment each year in this program (estimate an average)?_______________________________________

Approximately how many acres have *actually* been
treated each year (give a range, and estimate an average)?_______________________________________

E. If your “actual” acres ever lag behind “planned” acres, please rate each of the following factors according to *how often* it is responsible for this discrepancy. Rate as: 0 = never, 1 = sometimes, 2 = often, and 3 = always.
_____Inadequate resources (money, personnel) to conduct treatments
_____Unsuitable weather conditions for treatments
_____Air quality regulations
_____NEPA (National Environmental Protection Act) requirements
_____Political pressures
_____Lack of internal support or cooperation
_____Public opposition to treatments and treatment effects
_____Other:________________________________________________________________________________

Additional comments:

**7. Tools and information.**
Which of the following information and/or tools are currently used to support the fire and fuels management decisions in your management area (select all that apply)?
A. Fire history data
_____post-settlement fire records and observations (for example, fire atlas data)
_____pre-settlement data (for example, from fire-scarred trees)

B. Mapped data in GIS format (for example, ARC/Info, ArcView, GRASS)
_____fire occurrence records (fire perimeters)
_____ignitions
_____vegetation
_____fuels
_____topography
_____roads and trails
_____residences and other structures
_____other:________________________________________________________________________________

C. Mapped data *not* in GIS format (for example, paper maps)
_____fire occurrence records (fire perimeters)
_____ignitions
_____vegetation
_____fuels
_____topography
_____roads and trails
_____residences and other structures
_____other:________________________________________________________________________________

D. Computerized databases
_____FEIS (Fire Effects Information System)
_____NIFMID (National Integrated Fire Management Interagency Database)
_____Other computerized databases:_________________________________________________________

E. Computerized modeling tools

*Fire behavior/spread:*

_____BEHAVE
_____FARSITE
_____NEXUS
_____RERAP (Rare Event Risk Assessment Process)
_____FBP (Canadian Forest Fire Behavior Prediction System)
_____Other fire spread/behavior models:______________________________________________

*Fire danger/fire weather:*

_____AFFIRMS (Administrative and Forest Fire Information Retrieval and Management System)
_____CLIMATOLOGY
_____FIRDAT (or PCFIRDAT)
_____Firefamily+
_____MfFSF (Meteorology for Fire Severity Forecasting)
_____CFFDRS (Canadian Forest Fire Danger Rating System)
_____FWI (Canadian Forest Fire Weather Index System)
_____Other fire danger/fire weather models:______________________________________________

*Fire effects:*

_____CONSUME
_____EPM (Emissions Production Model)
_____FOFEM (First Order Fire Effects Model)
_____NFSPUFF
_____PLUMP
_____SASEM (Simple Approach Smoke Estimation Model)
_____SIAM (Structure Ignition Assessment Model)
_____VALBOX (Ventilated Valley Box Model)
_____Other fire effects models:______________________________________________

F. Other computer tools

_____FIRES (Fire Information Retrieval and Evaluation System)
_____FORBS (Fuels Out-year Request Budgeting System)
_____FVS-FFE (Forest Vegetation Simulator - Fire and Fuels Extension)
_____IIAA (Interagency Initial Attack Assessment)
_____CHA (Personal Computer Historical Analysis)
_____WFAS (Wildland Fire Analysis System)
_____WFSA_Plus98 (Wildland Fire Situation Analysis)
_____Other computer tools:______________________________________________

G. Other tools

_____HP
_____Fire danger rating pocket cards (FDRPC)
_____Fire behavior nomograms
_____Fuel model photo series
_____Research publications
_____Other:______________________________________________

Additional comments:

**8. Management challenges.**

A. What is most likely to prevent attainment of your management objectives?

B. Which of your management objectives most severely conflict with each other?

C. Is there a unique feature of your physical or social environment that makes decision-making especially difficult?

Additional comments:

**9. Natural or presettlement fire regime description.**

A. Tell us about your fire season.
What month does your fire season typically start?________________________________________
What month does your fire season typically end?________________________________________
In which month(s) is fire activity typically the highest?__________________________________

B. Indicate which of the following mean fire intervals (i.e., average time between fires) describe the *presettlement* fire regime(s) in your management area (select as many as apply).
_____0-25 years
_____25-100 years
_____100-300 years
_____300+ years
_____ I'm not sure what the presettlement fire frequency was in any part of my management area.
If you selected more than one of the fire interval categories, please try to estimate the percentage of land area that each category applies to. (For example, if your area had only ponderosa pine and lodgepole pine vegetation types, and was equally divided between the two, you might put 50% in the 0-25 and 100-300 categories, and 0% in the 25-100 and 300+ categories.)
_____% : 0-25 years
_____% : 25-100 years
_____% : 100-300 years
_____% : 300+ years

C. Indicate which of the following fire severity classes* describe the *presettlement* fire regime(s) in your management area (select all that apply). Note that this is *prior* to any fire suppression that may have occurred and prior to unnatural fuel accumulations that may exist as a result. (*We define fire severity as the total effect of fire on all plants, measured by the percent mortality of overstory plants. If you prefer to use a different classification scheme for fire severity, please use it, but be sure to define it for us.)
_____low severity: 0-30% mortality in overstory
_____moderate severity: 30-70% mortality in overstory
_____high severity: 70-100% mortality in overstory
_____I'm not sure what the presettlement fire severity was in any part of my management area.
If you selected more than one fire severity category, please try to estimate the percentage of land area each category applies to.
_____% : low severity
_____% : moderate severity
_____% : high severity

Comments:

**10. What else should we know about your fire management area and your management environment?**

**11. Please provide the following information about yourself. Your individual responses are confidential and will not be identified with you.**

What is your official job title?______________________________

For what agency do you work?______________________________

What is your telephone area code? (________)

How many years have you worked in fire and/or fuels management?______years

At what level are your primary management responsibilities?

_____District

_____Zone (2 or more districts)

_____Forest or Park

_____State

_____Region

_____Other:______________________________

**THANK YOU** very much for your time and thoughtful responses. To receive survey results please write your name and address on the back of the return envelope.

Comments about this survey:

# Appendix B. Questionnaire Summary Results

### QUESTION 1 (rate 0-3)

| | | |
|---|---|---|
| Developments/facilities | 2.19 | AVERAGE |
| Private property | 2.21 | AVERAGE |
| Timber values | 1.35 | AVERAGE |
| Recreational/scenic values | 1.43 | AVERAGE |
| Cultural sites | 1.55 | AVERAGE |
| Soil erosion/stream water quality | 1.35 | AVERAGE |
| Wildlife habitat | 1.53 | AVERAGE |
| Endangered/threatened species | 1.63 | AVERAGE |
| Forest health | 0.88 | AVERAGE |
| Post-fire exotic weed invasion | 1.07 | AVERAGE |
| Other unique natural resources | 1.14 | AVERAGE |
| Human life in the WUI | 2.15 | AVERAGE |
| Visitor safety | 1.99 | AVERAGE |
| Firefighter safety | 2.34 | AVERAGE |
| Controversial fire policy | 1.08 | AVERAGE |
| Political/public opposition to fire | 1.37 | AVERAGE |
| Smoke and air quality | 1.51 | AVERAGE |
| Heavy fuels | 1.81 | AVERAGE |
| Weather forecasts | 1.95 | AVERAGE |
| High fire danger | 1.89 | AVERAGE |
| Crown fire potential | 1.59 | AVERAGE |
| Multiple ignitions/nearby fire activity | 1.74 | AVERAGE |
| Insufficient staff—national fire activity | 1.56 | AVERAGE |
| Overextended staff/resources | 1.66 | AVERAGE |
| Insufficient time/staff--documentation | 1.14 | AVERAGE |
| Lack of fire management plan | 0.95 | AVERAGE |
| Interagency boundaries | 0.73 | AVERAGE |
| Conflicting management objectives | 0.99 | AVERAGE |

### QUESTION 2 (rate 0-3)

| | | |
|---|---|---|
| Reduced fuel hazards | 1.80 | AVERAGE |
| Reduced undesirable effects in future | 1.77 | AVERAGE |
| Reduced crown fire potential | 1.08 | AVERAGE |
| Increased future management options | 1.52 | AVERAGE |
| Improved resource conditions | 1.80 | AVERAGE |
| Improved wildlife habitat | 1.83 | AVERAGE |
| Enhanced wildness/naturalness | 1.79 | AVERAGE |
| Allowing natural processes | 2.26 | AVERAGE |
| Enhanced vigor and growth | 1.78 | AVERAGE |
| Increased regeneration | 1.32 | AVERAGE |
| Reduced suppression costs | 1.57 | AVERAGE |
| Reduced smoke in future | 1.33 | AVERAGE |

### QUESTION 3 (rate 0-3)

| | | |
|---|---|---|
| Increased fuel hazards | 1.74 | AVERAGE |
| Increased future threats to values | 1.71 | AVERAGE |
| Increased crown fire potential | 1.13 | AVERAGE |
| Reduced future management options | 1.38 | AVERAGE |
| Reduced fire-dependent habitat | 1.77 | AVERAGE |
| Degraded ecosystem health | 1.70 | AVERAGE |
| Increased suppression costs | 1.52 | AVERAGE |
| Increased smoke in future | 1.38 | AVERAGE |

### QUESTION 4

| | | |
|---|---|---|
| Major focus of land management goals | | |
| Recreation | 107 | TOTAL |
| Commodity | 63 | TOTAL |
| Cultural | 73 | TOTAL |
| Ecosystem | 128 | TOTAL |
| Wildlife | 117 | TOTAL |
| Ranking of above (1=most important) | | |
| Recreation | 2.97 | AVERAGE |
| Commodity | 2.84 | AVERAGE |
| Cultural | 3.30 | AVERAGE |
| Ecosystem | 1.75 | AVERAGE |
| Wildlife | 2.32 | AVERAGE |

### QUESTION 5

| | | |
|---|---|---|
| Fire management strategies used | | |
| Full suppression | 140 | TOTAL |
| Confinement | 90 | TOTAL |
| Wildland fire use | 93 | TOTAL |
| Percent of fire starts managed by each strategy in last 10 years | | |
| % : Full suppression | 78.03 | AVERAGE |
| % : Confinement (limited suppression) | 7.41 | AVERAGE |
| % : Wildland fire use | 14.52 | AVERAGE |
| Percent of fire starts managed by each strategy in next 1-3 years | | |
| % : Full suppression | 68.27 | AVERAGE |
| % : Confinement (limited suppression) | 9.35 | AVERAGE |
| % : Wildland fire use | 22.56 | AVERAGE |

## QUESTION 6

| Active fuels treatment program | | |
|---|---|---|
| Yes | 137 | TOTAL |
| No | 9 | TOTAL |

| Fuels treatment objectives (rate 0-3) | | |
|---|---|---|
| Reduce fuel loadings | 2.23 | AVERAGE |
| Reduce potential suppression costs | 1.40 | AVERAGE |
| Reduce potential damage from wildfire | 1.87 | AVERAGE |
| Reduce future wildfire size | 1.60 | AVERAGE |
| Reduce future wildfire intensity | 1.81 | AVERAGE |
| Simulate effects of natural disturbance | 1.72 | AVERAGE |
| Restore/maintain historic scenes | 1.05 | AVERAGE |
| Resource enhancement | 2.05 | AVERAGE |

| Fuels treatment methods included | | |
|---|---|---|
| Naturally ignited fire | 62 | TOTAL |
| Prescribed fire | 132 | TOTAL |
| Cuttings and mechanical | 113 | TOTAL |
| Combination of prescribed fire/ mechanical | 115 | TOTAL |
| Herbicide | 43 | TOTAL |
| Grazing | 32 | TOTAL |

| Percent acres treated to date | | |
|---|---|---|
| Naturally ignited fire | 6.66 | AVERAGE |
| Prescribed fire | 60.52 | AVERAGE |
| Cuttings and mechanical | 13.05 | AVERAGE |
| Combination of prescribed fire/mechanical | 14.02 | AVERAGE |
| Herbicide | 2.27 | AVERAGE |
| Grazing | 3.78 | AVERAGE |

| Factors for prioritizing fuels treatments (rate 0-3) | | |
|---|---|---|
| Economic feasibility | 2.09 | AVERAGE |
| Administration as wilderness | 1.00 | AVERAGE |
| Proximity to wilderness boundary/WUI | 1.93 | AVERAGE |
| Presettlement fire frequency | 1.39 | AVERAGE |
| Current fuel hazards | 2.21 | AVERAGE |
| Likelihood of severe wildfires | 1.74 | AVERAGE |
| Probability of ignition | 1.46 | AVERAGE |
| Type of values to be threatened by wildfire | 1.99 | AVERAGE |
| Vegetation type | 2.29 | AVERAGE |
| Topographic position | 1.54 | AVERAGE |
| Post-treatment recovery potential | 1.71 | AVERAGE |

| General background | | |
|---|---|---|
| Years with active fuels treatment program | 17.95 | AVERAGE |
| Acres planned each year | 20052.50 | AVERAGE |
| Actual acres treated each year | 12238.12 | AVERAGE |

| Factors responsible for actual acres treated less than planned (rate 0-3) | | |
|---|---|---|
| Inadequate resources | 1.35 | AVERAGE |
| Unsuitable weather conditions | 1.87 | AVERAGE |
| Air quality regulations | 1.22 | AVERAGE |
| NEPA requirements | 1.05 | AVERAGE |
| Political pressures | 0.99 | AVERAGE |
| Lack of internal support/cooperation | 0.77 | AVERAGE |
| Public opposition to treatments | 0.77 | AVERAGE |

## QUESTION 7

| Fire history data | | |
|---|---|---|
| Post-settlement fire records | 121 | TOTAL |
| Pre-settlement data | 95 | TOTAL |

| Mapped data in GIS format | | |
|---|---|---|
| Fire occurrence records | 104 | TOTAL |
| Ignitions | 94 | TOTAL |
| Vegetation | 117 | TOTAL |
| Fuels | 92 | TOTAL |
| Topography | 104 | TOTAL |
| Roads and trails | 111 | TOTAL |
| Residences | 83 | TOTAL |

| Mapped data not in GIS format | | |
|---|---|---|
| Fire occurrence records | 70 | TOTAL |
| Ignitions | 54 | TOTAL |
| Vegetation | 53 | TOTAL |
| Fuels | 64 | TOTAL |
| Topography | 52 | TOTAL |
| Roads and trails | 56 | TOTAL |
| Residences | 80 | TOTAL |

| Computerized databases | | |
|---|---|---|
| FEIS | 111 | TOTAL |
| NIFMID | 42 | TOTAL |

| Fire spread/behavior models | | |
|---|---|---|
| BEHAVE | 136 | TOTAL |
| FARSITE | 58 | TOTAL |
| NExUS | 16 | TOTAL |
| RERAP | 51 | TOTAL |
| FBP | 12 | TOTAL |

| Fire danger/fire weather models | | |
|---|---|---|
| AFFIRMS | 67 | TOTAL |
| CLIMATOLOGY | 34 | TOTAL |
| FIRDAT | 40 | TOTAL |
| Firefamily+ | 90 | TOTAL |
| MfFSF | 5 | TOTAL |
| CFFDRS | 11 | TOTAL |
| FWI | 9 | TOTAL |

| Fire effects models | | |
|---|---|---|
| CONSUME | 62 | TOTAL |
| EPM | 14 | TOTAL |
| FOFEM | 80 | TOTAL |

| | | |
|---|---|---|
| NFSPUFF | 25 | TOTAL |
| PLUMP | 6 | TOTAL |
| SASEM | 75 | TOTAL |
| SIAM | 2 | TOTAL |
| VALBOx | 8 | TOTAL |
| Other computerized tools | | |
| FIRES | 35 | TOTAL |
| FORBS | 43 | TOTAL |
| FVS-FFE | 10 | TOTAL |
| IIAA | 56 | TOTAL |
| PCHA | 59 | TOTAL |
| WFAS | 53 | TOTAL |
| WFSA_Plus98 | 97 | TOTAL |
| Other tools | | |
| HP | 27 | TOTAL |
| Fire danger rating cards | 56 | TOTAL |
| Fire behavior nomograms | 81 | TOTAL |
| Fuel model photo series | 102 | TOTAL |
| Research publications | 98 | TOTAL |

**QUESTION 9**

| | | |
|---|---|---|
| Mean fire interval category | | |
| 0-25 years | 98 | TOTAL |
| 25-100 years | 94 | TOTAL |
| 100-300 years | 74 | TOTAL |
| 300+ years | 34 | TOTAL |
| I'm not sure | 11 | TOTAL |
| Percent land area in each fire interval category | | |
| 0-25 years | 42.74 | AVERAGE |
| 25-100 years | 30.02 | AVERAGE |
| 100-300 years | 18.22 | AVERAGE |
| 300+ years | 9.13 | AVERAGE |
| Fire severity classes | | |
| Low severity | 95 | TOTAL |
| Moderate severity | 83 | TOTAL |
| High severity | 67 | TOTAL |
| I'm not sure | 19 | TOTAL |
| Percent land area in each severity class | | |
| Low severity | 48.19 | AVERAGE |
| Moderate severity | 30.70 | AVERAGE |
| High severity | 21.08 | AVERAGE |

**QUESTION 11**

| | | |
|---|---|---|
| Years in fire/fuels management | 21.09 | AVERAGE |
| Level of management | | |
| District | 24 | TOTAL |
| Zone (2 or more districts) | 23 | TOTAL |
| Forest or Park | 64 | TOTAL |
| State | 15 | TOTAL |
| Region | 10 | TOTAL |
| Other: | 28 | TOTAL |

# Appendix C. Workshop Participants

Lou Ballard, *Zone Fire Management Officer, United States Fish and Wildlife Service*

Joe Carvelho, *Forest Fire Management Officer, United States Forest Service, Salmon-Challis NF (retired)*

Randy Doman, *Deputy Fire Staff Officer, United States Forest Service, Nez Perce NF (retired)*

Rod Dykehouse, *Zone Fire Management Officer, United States Forest Service, Bridger-Teton NF*

Tobin Kelley, *Fuels Specialist, United States Forest Service*

Jack Kirkendall, *Forest Fire Management Officer, United States Forest Service, Bitterroot NF*

Rich Lasko, *Fire Planning and Development, United States Forest Service, Region 1*

Erin Law, *Wilderness Fire Specialist, United States Forest Service, Nez Perce NF*

Donald Long, *Research Ecologist, United States Forest Service, Fire Sciences Laboratory*

Melanie Miller, *Fire Ecologist, Bureau of Land Management*

Wayne Mitchell, *Staff Chief Pre-fire Operations and Planning, California Department of Forestry and Fire Protection*

Tim Rich, *Region/State Fuels Specialist, United States Forest Service, Region 6*

Darrell Schulte, *Forest Fire Management Officer (acting), United States Forest Service, Beaverhead-Deerlodge NF*

Chuck Stanich, *Fire Fuels Specialist, United States Forest Service, Bitterroot NF*

# Appendix D. Information Items That Affect Strategic Fuels Management and Wildland Fire Use Decisions

### Fire items

Historical weather
Fire activity (local, regional, national)
Location of fire
Weather forecasts
Departure from normal conditions
Projected fire size
Administration designation
Whether fire use is allowed
Land and fire management objectives (differences in land use; changes in administrative use in response to public expectations)
Air quality
Fire danger rating (seasonality + departure)
Multiple ignitions
Fire behavior
Expected fire effects (weeds, soil, wildlife, etc.)

### Items of Comparison Between Historic and Current Fire Regimes

Intensity/severity
Fire return interval
Size
Size over time
Occurrence pattern (periodicity)
Time of season (fuels moisture, ecological effects)
Fuels complex (horizontal/vertical)
Species composition
Land use practices (historic)
Climate
Condition class

### Social items

Air quality (nuisance, visibility)
Aesthetics
Not In My Back Yard
Alternative perceptions of effects
Recreation limitations
Commodity/economic limitations
Perception of law/liability
Perception of ability to control (public expectations)
Public understanding of policy and effects
Perception of who is responsible?
Political pressure
Public resistance to change
Changes in public expectations for the land (agency understanding of public values)
Public safety
Differences in current land use
Differences in public perception of current land use

Consequences of failure (effects, management, social)
Private property
Cultural sites
Wildlife, T&E

### Managerial items

Fire activity
Administrative designation
Fire management objectives
Agency/employee understanding of policy and effects
Agency understanding of public values
Risk tolerance of agency/line officer
Management capacity (appropriate staffing, resources, supervisory capability)
Ability to change in response to changes in public expectations for the land
Administrative boundaries (proximity to boundary)
Employee safety
Available resources
National preparedness levels
Proximity to boundary
Consequences of failure
Risk aversion/posture
Wildlife, T&E
Cultural sites
Land management objectives

### Desired information items

Fuels map (detailed, accurate, dynamic) with attribute data
Vegetation map (detailed, accurate, dynamic) with attribute data that derives fuels and wildlife habitat requirements
Probabilistic pixel-specific daily weather streams
Hourly long term weather forecasts (90 day)
Multi-year drought index (10 yrs)
Detailed map of cultural sites with zoom-in-ability and susceptibility to fire
Detailed map of improvements (i.e., structures) with zoom-in-ability and susceptibility to fire
Detailed map of T&E with attribute data
Detailed map of weeds
Model of noxious weed/invasive exotic/type conversion potential
Disturbance history
Fire regimes
Knowledge and predictive model of fire effects
Historical vegetation and animal dynamics
How to achieve natural fire effects in current unnatural fuels
Probability of co-occurring fire weather, ignition, fuel conditions (probability of management opportunities)
Value of noncommodity resources
Long term consequences of management decisions and actions
What the public wants from federal lands in 30 years
Good fire behavior prediction in rangeland/woodland (nonforest) fuels

RMRS
ROCKY MOUNTAIN RESEARCH STATION

The Rocky Mountain Research Station develops scientific information and technology to improve management, protection, and use of the forests and rangelands. Research is designed to meet the needs of the National Forest managers, Federal and State agencies, public and private organizations, academic institutions, industry, and individuals.

Studies accelerate solutions to problems involving ecosystems, range, forests, water, recreation, fire, resource inventory, land reclamation, community sustainability, forest engineering technology, multiple use economics, wildlife and fish habitat, and forest insects and diseases. Studies are conducted cooperatively, and applications may be found worldwide.

**Research Locations**

| | |
|---|---|
| Flagstaff, Arizona | Reno, Nevada |
| Fort Collins, Colorado* | Albuquerque, New Mexico |
| Boise, Idaho | Rapid City, South Dakota |
| Moscow, Idaho | Logan, Utah |
| Bozeman, Montana | Ogden, Utah |
| Missoula, Montana | Provo, Utah |
| Lincoln, Nebraska | Laramie, Wyoming |

*Station Headquarters, Natural Resources Research Center, 2150 Centre Avenue, Building A, Fort Collins, CO 80526.



Federal Recycling Program Printed on Recycled Paper